THE
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THE SCRAP HEAP.

So much has been written under American auspices as to the Englishman's ignorance of the value of a scrap heap, that were it all true there would be nothing left for us to do but to go out of business forthwith. In spite of all the ruin prophesied, English goods seem to be gaining upon the foreigner in many directions, and when they do come off second it is usually because of a price that cannot be afforded or because of some question of delivery. Many thousands of people in this world use electro-plate, but it is not that they do not prefer solid silver, nor is it that the expense of upkeep of silver frightens them; it is purely a question of the first cost. Evidence is continually cropping up that points strongly to the real cheapness of the best and most durable articles. The experience of the Egyptian railways is a case in point. British engines were shown to be incontrovertibly superior to, and cheaper than, Belgian engines. The Belgian engines, even when increased in price by tube renewals and renewals of other bad material, were cheaper than American engines proved to be with their heavy coal and repair bills.

Much is being constantly written concerning the rapid scrapping of obsolete tools to make room for newer tools of greater speed. A great deal of this is nonsense. The regular run of ordinary machine tools is not being so rapidly improved that it pays to scrap them every two or three years. Yet it is absolutely necessary to scrap many American tools in this period of time, purely because they are worn out and unfit to do good work. Just as the cottar's pig was killed to save its life—commercially, of course—so the scrap heap is made a virtue, because it really is a necessity.

In looking over a large number of machine shops, it is obvious that there are necessities of far greater importance than the scrapping of the old machinery. New tools have been put down under a leaking roof. They are crowded into a dark corner where not one-half of their utility and convenience can be secured. They are even placed on a dirty floor which will help quickly to spoil them. The excessive cost of manufacture is by no means always to be set down to the fault of tools. It is just as often the fault of arrangements. People who pride themselves on the excellence of their products, are content to carry on their business in a veritable rabbit warren of old dilapidated buildings, with small grimy windows, uneven patched floors, and unventilated rooms communicating in series by means of up and down bits of dark stairway. No supervision is possible. Materials are carried to and fro at great expense, and purchasers are gravely assured, though the price asked may be high, it does not represent an extravagant profit. Of this there is very little doubt. But the high prices ought to represent an extravagant profit, and only fail to do so, because of the badly-arranged workshops. New tools in such a

shop are, if not a useless expense, at least not the most important want. Yet the proprietors of these shops never seem able to grasp the significance of the position. They know there is something wrong. They are tempted to think that they need some new tools, but do not realise that their buildings are at fault.

To show the error of following American precedent, let the automatic machine be considered. This machine cuts articles, such as bolts, out of solid rods, and it cuts a large weight of material to waste. For small articles the system is good, but it has been carried too far. Large bolts cut out of the solid bar are unsafe and, like humans, are apt to lose their heads without warning. A good forging machine makes sound work and can be cheaply combined with screwing machines, while the hopper automatic may be employed on many articles now faultily made on rod-feed machines.

Then, again, while automatic machines with rod feed are excellent for certain small parts, it is found that the stock used in them is so soft that the resulting products are not what they should be, and soft yellow brass is used for parts that should be of good gun-metal. Manufacturing engineers who are considering re-organisation should remember these points, and not too hastily throw away good quality for the sake of a cheapness which will rob them of their character. The craze for cheapness and rapid delivery has had a certain free run which is beginning to show results. Purchasers are beginning to find out something of durability, wear, breakage and repairs, and it is apparently not resulting badly for the despised Englishman.

Uninstructed writers in the daily press have been very garrulous on the subject of scrap heaps. They are evidently ignorant of the two uses to which a scrap heap is put. The only one they know of is to receive obsolete material. The other use is to receive worn-out material. The Americans are great scrappers, but it is rather because of this second necessity which, however, is usually concealed behind the pretended first cause. It may pay the Americans to manufacture cheap stuff of no durability; they talk freely of the Englishman's ignorance of the use of a scrap heap, yet half the bridges in America would be promptly scrapped in Great Britain. It is all a question of circumstances. The Americans may have been right in the construction of cheap locomotives, right for America, but wrong for most other countries. That they have been wrong in their ideas of machine tools is proved by the rapid increase in their weight since they were brought into competition with English tools.

Further, the more settled parts of the States are differentiating their practice from the newer States in every line, and modern practice is approximating to European standards every year. Bridges of masonry are now quite common in America.

Our contemporary, the *Engineer*, states that, of the concerns absorbed by the big trusts in America, those with the oldest appliances were paying the best dividends, and finds that there is, perhaps, a limit to the commercial value of early scrapping. Americans who come over to this country are too usually imbued with a sense of American superiority in everything, and they have been declared by one of themselves to be useless for the first three years, which time they require to learn their way about. The sensible ones find out that practice is a matter of environment. Blindly to follow American methods is to court failure. There is much to be learnt from them, and much to be as carefully avoided; and on the question of scrapping, we should advise most of the old-fashioned firms to start with their buildings, and to be cautious and discriminating before exchanging tools that are still good for others that will wear out too rapidly. Before purchasing a new tool that is promised to do double the work of the old one, make a genuine test of the old tool, to see whether it will not do double or treble what it has been hitherto set to do. Very much of insufficient output is caused by not trying to do better.

Single-Phase Electric Traction.

We commence in this issue the reproduction of a paper read before the American Institute of Electrical Engineers by Mr. B. G. Lamme, which calls for the most careful attention of electrical and railway engineers. Briefly, after pointing out the overwhelming superiority of the series-wound motor for electric traction, the importance of a *single* overhead conductor instead of two, and the necessity of high pressure for long-distance railway working—all of which points have been insisted upon in these pages from time to time—the author states that the Westinghouse Co. has solved the problem of combining these features in the simplest possible manner, namely, by the adoption of single-phase alternating current, in conjunction with a series-wound motor and step-down transformers!

Of course, the field magnets of the motor have to be thoroughly laminated, and the design of the windings radically modified. Such motors, in small sizes, were in common use prior to the advent of the modern induction motor, and it is somewhat significant that they have gone completely out of use; but it should be remembered that the frequencies then in vogue were in the neighbourhood of 100 cycles per second, while for railway purposes the frequency will be as low as 15—quite a different matter.

We do not profess to have as yet studied the pros and cons. of this remarkable departure; the author states, it is true, that experiments which have been made by the Westinghouse Co. have satisfactorily proved that all the difficulties—even that of commutation—can be successfully overcome. But the subject is one of such paramount importance, that we must be prepared to give the most careful consideration to any scheme which possesses even the faintest semblance to a solution of the problem of main line traction. In this connection credit ought, we think, to be given to Messrs. Mordey and Jenkin for their early recognition of the advantages of the single-phase system, even though we were unable to approve of the complicated method by which they proposed to carry it into application.

Jargon.

We have become accustomed by this time to find most extraordinary information regarding science and its exponents in non-scientific journals, but we confess we were not prepared for the remarkable statements regarding Lord Kelvin, which our new contemporary, the *Car*, published two weeks ago. We are told that Lord Kelvin "has worked steadily all his life at original research, and has discovered at least two new elements, *argon and electron!*" We had always understood that the physicist to whom the discovery of argon is credited is another eminent peer, Lord Rayleigh, and we believe that Lord Kelvin shares this opinion, but we are evidently all wrong. It has remained for the *Car* to put us right, and to show Lord

Kelvin as a discoverer deliberately attempting to credit another man with his own inventions. We know Lord Kelvin to be an extremely modest man, but we had not suspected him of this treachery. But now for a greater surprise still! The new *element, electron!* Until now we had in our ignorance imagined that the name "electron" had nothing to do with the chemical elements as such, and we believed that Lord Kelvin, who is responsible for many electrical terms now in general use, had nothing at all to do with the introduction of this particular term; but here again the whole electrical world is in error, and only a journal devoted to motoring, as practised in Society, has been aware of the truth. The writer expresses the hope that among Lord Kelvin's next discoveries will be improvements in the petrol engine and flash boiler, but is he quite sure that neither of these was invented by the great electrician? A writer who, in sketching the career of Sir William Thomson can omit all mention of his Professorship at Glasgow University, and who knows so much more regarding the elements than Lord Kelvin and the rest of mankind, need not have stuck at the trifle of imagining the invention of the motor car to be due to the subject of his article.

Electromobiles in America.

It would appear that makers of electromobiles, both in England and America, are not very keen about entering into contests. It will be fresh in the minds of our readers that the electrical vehicle trials which were being arranged by our own Automobile Club a few months ago had to be abandoned through lack of entries. It is now certainly interesting and regrettable, to hear that our American friends have gone only one better, notwithstanding the glowing reports that we receive from time to time of the flourishing state of the electric automobile industry in the States. Can it be that industrial activity keeps manufacturers too busy to make it worth their while to trouble about competitions? It is worth remembering that the makers whose machines come out well in the trials would be amply repaid by the excellent advertisement they would obtain.

Only one electric automobile was entered in the reliability run between New York and Boston, from October 9th to 15th, and this was so, in spite of the fact that the conditions of the contest "seemed particularly suitable to electric machines," to quote our New York namesake. Charging or exchanging batteries was allowed in the morning and at noon. High speeds were not allowed, so that wear and tear on the batteries should be slight. The longest half-day run, from Springfield to Worcester, was but 52 miles. Our contemporary expresses the opinion that there are a number of electric vehicles made in the States which could meet these conditions successfully. We are quite confident, from previous performances, that there are English cars which could easily come up to such requirements. We read that "electric wagons are widely used in the large American cities, and it is reported that long and careful records of these vehicles have been kept by a Brooklyn firm, which records demonstrate the entire success of these machines for their work."

It has been said that the demand for automobile batteries is so small, that the American accumulator manufacturers are making no efforts to cultivate or extend it. As our exchange very correctly says, this is not the proper spirit to adopt, as the same criticism could be made of any new industry. For ourselves, we believe that English manufacturers and inventors have been assiduously engaged for years past hunting up the ideal accumulator for motor car work, and they are still at work thereon as hard as ever. But we thought that the salvation of the situation had already been worked out in America! What has become of Mr. Edison's new battery which was going to show such startling performances? A few months ago it was said that it was to be demonstrated practically in these American reliability trials, and then the statement was contradicted, presumably because the cell has not emerged from its laboratory stage. It certainly looks now as if the severely critical comments which we passed upon this so-called advance in secondary battery developments at the time when it was boomed in the non-technical press, have been entirely justified.

Electromobilism numbers us among the most ardent of its well wishers, and every genuine and practical advance either in motor car design or in automobile batteries will be welcomed by us with open arms; but is it not a bit curious that some electrical engineers should busy themselves with enthusiastic advocacy of the cause of automobilism, to the detriment of their own electric tramway industry, when the electromobile battery is not yet quite ready to meet the case? Evidently the immediate benefit of electrical manufacturing industry is not their first concern.

Efficiency of Electric Furnace Operations.

A paper bearing the above title was read before a recent meeting of the American Electro-chemical Society by Prof. J. W. Richards, the President. Dr. Richards defines the efficiency of a furnace in which electrolytic action takes place, as the ratio of the E.M.F. theoretically required to that actually found necessary to bring about the reaction. In a continuous (*i.e.*, continuously-working) non-electrolytic furnace, the corresponding ratio is that between the useful or unradiated heat energy to the total energy supplied. In an intermittent furnace the ratio is similar; but whereas a continuous furnace may, with advantage, have a large thermal storage capacity—for such a property makes for uniformity in the product by avoiding sudden changes in temperature—the thermal capacity of an intermittent furnace should be as small as possible. Moreover, as the amount of heat lost by radiation is a function of time as well as of temperature, both types of furnace are rendered more efficient by being run quickly. Prof. Richards finds that the intermittent furnace is the most efficient apparatus, and the electrolytic furnace the least. This seems opposed to common sense, for, at least in most other departments of industry, the manufacturer economises, notably when he converts his intermittent method into a continuous process. Apparently the same rule should apply in electric furnace work, and if it does not, surely the continuous furnace needs, and should be capable of, great improvement. The true efficiency of an electrolytic operation is perhaps less susceptible of accurate measurement, because most thermo-chemical data require revision, and some have yet to be determined. Thermo-chemistry is, and always has been, under a cloud, which is particularly unfortunate now that electro-chemistry and electro-metallurgy are becoming so important. An investigation, both at high and low temperatures, of the constants of substances likely to be put into the furnace would prove a most welcome addition to our stock of physico-chemical knowledge.

Free Lamps.

On another page we publish an abstract of a symposium read before the National Electric Light Association of America on this subject. The practice of renewing worn-out lamps gratis on the part of the supply company is not uncommon in America, but for some reason it has never attained much popularity in this country, almost the only place where it is in vogue being the City of Bradford. In these days, when every effort is being made to popularise the supply of electricity, the subject is one which ought not to be overlooked by station managers. The gas companies have found that great benefits accrue from a similar procedure with respect to the incandescent mantle—the greatest rival of the glow lamp—and what is good for them may well be good for electrical undertakers.

D

STANDARDISATION IN CHEMICAL ANALYSIS.

In an excellent paper bearing the above title, read before the British Association by Mr. Bertram Blount, of Westminster, we find a timely and authoritative—if we may use a word wholly opposed to the spirit of the writer—protest against the injudicious manner in which so many persons are advocating standardisation at the present day. When the manufacturer calls in an expert to assist him, he requires one of two totally dissimilar things: he either seeks to know how a certain material is composed, or what proportion of a given ingredient it contains; or he is anxious to learn how that material will behave under specified conditions. To answer the first inquiry is a matter of pure chemistry; the second demands an exact reproduction of the necessary conditions, which means a faithful, unquestioning, obedience to instruction. Suppose the percentage of carbon in steel be sought; the steel inevitably contains a certain proportion and no other, and the method adopted to determine it accurately is either competent to do so, or the reverse. But the chemist employed to make the analysis is also either competent or not; and if he is competent as an analyst, he must *ex hypothesi* be perfectly competent to recognise the value of any particular method, and to select or devise a new one on his own account. On the other hand, the temperature at which an oil "flashes" is no inherent property of that oil; it flashes at a temperature depending on the size and construction of the vessel in which it is heated. The chemist making this test, therefore, must work according to rule, or his results will admit of no comparison with those obtained in other laboratories. Empirical or arbitrary figures must be deduced by empirical or arbitrary processes, as their value is but empirical and arbitrary. Absolute figures whose dimensions represent ultimate chemical facts may often be obtained by several different methods, all equally accurate; but no method, based on sound chemistry, and not a mere "cookery recipe," can be made one jot more exact, or one tittle more admirable by receiving the benedictions of a committee of Freseniuses.

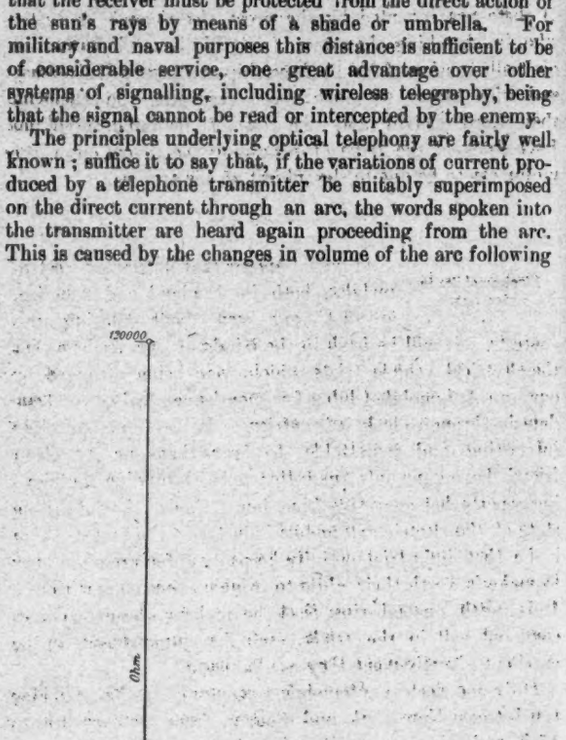
Of course, it is notorious that disputes frequently occur in commercial analysis, and equally, of course, one of the analyses (if not both) must be wrong. But the imposition of a standard is almost as likely to cause both reports to agree by similarity of error, as to bring about a uniformity of correctness. The errors of two different processes will probably be different; the errors of one process will always be the same, and, as constants, invisible. Most of the lack of agreement in technical analysis is due to imperfect sampling—for the sampling of a heterogeneous material is extraordinarily difficult; much of the remainder depends on the impatience with which the commercialist awaits his report. Occasionally, when one of the analyses has been carried out by a works chemist, an unsuitable method has been employed in an unskilful fashion; but then, as Mr. Blount urges, and as we argued a few weeks ago, the fault is primarily that of the manufacturer, for putting into his laboratory a man who only by courtesy can be called a chemist.

The whole matter, in chemistry, in mechanical engineering, &c., is only one narrow phase of the question of cheapness in prime cost *versus* permanence, of rapidity in production *versus* suitability to the particular ends in view. A manufacturer may secure a larger turnover, and, indeed, a larger net profit (for a time), by making a million absolutely identical articles; but he will undoubtedly lay firmer foundations for future prosperity by contenting himself with the construction of a thousand, all carefully designed to meet the peculiar requirements of each separate customer. The former involves a sacrifice of perfection to expediency; the second of "pre-eminence" in quantity to predominance in quality. To do the first successfully requires much commercial ability; but the second demands a far higher skilled intelligence, which is deserving of all praise, and which goes not without its reward even in a world that appears to be largely governed by and for the whims of millionaires.

RECENT EXPERIMENTS ON OPTICAL TELEPHONES.

It is only about four years since the first experiments were made on the speaking arc lamp; and to those to whom these first experiments were shown, it seemed that what they then saw demonstrated was only of the nature of an interesting scientific toy. But already a great development has taken place, which promises to make the matter of some practical importance as a solution of the problem of wireless telephony. Herr Ernst Ruhmer contributes to the *Electrotechnische Zeitschrift* for September 25th, 1902, an interesting description of his latest experiments in this direction. By the means adopted he has been able to telephone with good effect for a distance of 7 kilometres, by day as well as by night, the only precaution necessary in the former case being that the receiver must be protected from the direct action of the sun's rays by means of a shade or umbrella. For military and naval purposes this distance is sufficient to be of considerable service, one great advantage over other systems of signalling, including wireless telegraphy, being that the signal cannot be read or intercepted by the enemy.

The principles underlying optical telephony are fairly well known; suffice it to say that, if the variations of current produced by a telephone transmitter be suitably superimposed on the direct current through an arc, the words spoken into the transmitter are heard again proceeding from the arc. This is caused by the changes in volume of the arc following



Resistance-Illumination Curves of Selenium Cell.

the changes in temperature of the same caused by the varying current density. The changing temperature of the arc is also the cause of a corresponding varying emission of light, and it is the latter which is used to transmit the wireless telephonic message. The fluctuations in the light emission are so quick that they cannot be seen by the eye; a receiver has, however, been found which is able to follow and respond to them.

In order to send the message in the required direction, Ruhmer employed a parabolic reflector made by Messrs. Schuckert, with a diameter of 350 mm. A hand-fed arc lamp supplied with current from a battery was used, the current strength for 1 to 2 kilometres being 4 to 5 amperes; for 3 to 4 kilometres, 8 to 10 amperes; and for 5 to 7 kilometres, 12 to 16 amperes.

The receiver consisted of a similar parabolic mirror, in the optical axis of which a cylindrically formed selenium cell was placed, in series with two telephones and a battery. Selenium has the property of changing its resistance with the illumination falling upon it. The varying light beam from the transmitting station is concentrated by the receiver mirror on to the selenium cell, the resistance of which varies in accordance with the microphonic currents in the transmitter. The current through the receiver telephone varies likewise, with the result that the word-sounds spoken into the microphone are repeated therein. This appears, at first sight, to be very simple, but, of course, before it could be done, a great deal of experimenting had to be carried through. The chief difficulty has been the selenium cell. The cells formerly used were hardly affected by short light waves (those made use of in optical telephony), but Ruhmer has now constructed cells which are especially sensitive for these; in fact, he can render them sensitive for any wave length he chooses. It was also necessary that the cell should change its resistance quickly, so as to follow the quick variations. There are two modifications of selenium obtained by the transformation of the amorphous into the crystalline variety, the "hard" and the "soft" modification. The former is better for use in the day time and the latter at night. All the various good qualities necessary are combined in Ruhmer's cells, which he encloses in a vacuum inside a thin glass tube. The figure on the opposite page shows the resistance-illumination curve of one of the cells.

The experiments were carried out on the Wannsee and the Haver, near Berlin, where 7 kilometres was the longest distance available. Further experiments are now in hand at another place for a distance of 15 kilometres. We shall look with great interest for the results of these additional tests.

C. C. G.

THE THEORY OF THUNDERSTORMS.

The Picking-Up of Negative Electricity from the Air by Raindrops.

The phenomena of terrestrial and atmospheric electricity, though they were probably the first to attract the attention of the primeval electrician, offer even in the present comparatively advanced state of our knowledge as many, if not more, unsolved problems as any other branch of electrical science. Take, for example, the permanent negative charge of the earth, which is known to be about 160,000 volts. What process in the economy of nature gives rise to, and maintains this charge? Elster and Geitel have suggested that it is due to the pouring-in of free negative ions from the atmosphere into the earth. Wilson has shown that negative ions in the air form more active nuclei for the formation of raindrops than the positive ions, and this circumstance may lead to an excess of negative electricity being carried to the earth by rain. Lenard, on the other hand, has shown that when raindrops or waterdrops of waterfalls are shattered by impact with the earth's surface they impart positive electricity to the earth and negative electricity to the air. This latter process would, if not counteracted, impart a positive charge to the earth instead of a negative. Lenard, however, also found that if the falling waterdrops contained in solution a certain percentage of salt, the process was reversed, and therefore we have in the dashing of the waves of the sea against its shores a process that contributes to the negative charging of the earth.

Herr Schmauss, in an interesting contribution to the *Annalen der Physik* (Vol. 9, p. 224), shows that there is still another natural process continually at work which tends to maintain the high negative charge of the earth.

Schmauss started with the intention of finding out whether the artificial ionisation of the air through which the water drops fell had any influence on the Lenard effect. The water drops were allowed to fall on the bottom of an insulated metallic vessel, connected to one terminal of an electrometer, the other terminal of which was connected to earth. The insulated vessel and the water-dropping nozzle were enclosed in a metal container, to screen off the effects of external electrical charges.

After the water dropping started, the electrometer indicated a gradual accumulation of positive electricity, due to the Lenard effect. But it was noticeable that the increase of the positive charge was slower at starting than after some time had elapsed. This was when the air through which drops fell was ordinary atmospheric air. When the air was ionised by exposure for some time to the Röntgen rays, the electrometer swung for a short time to the negative side, and then gradually returned to the positive side, towards which it continued to move.

Schmauss proceeded to determine whether this production of negative electricity, when the air was ionised, took the place of the Lenard effect, or whether it was merely superadded to it. To test this he weakened the Lenard effect by allowing the water drops to fall on sheets of wire gauze, instead of on a solid metal plate. If the new effect had simply replaced the Lenard effect, it ought to be reduced by the same means; if it were superadded, and the resultant effect was due to the difference, then when the Lenard effect was weakened, the production of negative electricity ought to be more marked in the movements of the electrometer needle. The latter was found to be the case.

The explanation arrived at by Schmauss was that the water drops, in falling through the air, picked up an excess of negative ions, and thus became negatively charged. Zeleny (*Phil. Mag.*, 46, p. 120, 1898) has shown that an insulated plate, against which a current of ionised air is directed, becomes negatively charged, on account of the greater velocity of the negative ions. The conditions are the same when a water drop falls through ionised air, the only difference being that in the latter case the air is stationary, and the conductor moves. The conclusion therefore was highly probable that the water drops pick up free negative ions in falling through the air. Many other experiments were made by Schmauss to confirm this view.

At first, when the air was rich in negative ions, the water drops acquired enough negative electricity to counteract the positive charge due to the Lenard effect. But gradually the available negative ions get washed out of the air, and the positive Lenard effect again predominates. Hence the initial swing of the electrometer needle to the negative side, followed by the permanent movement to the positive side.

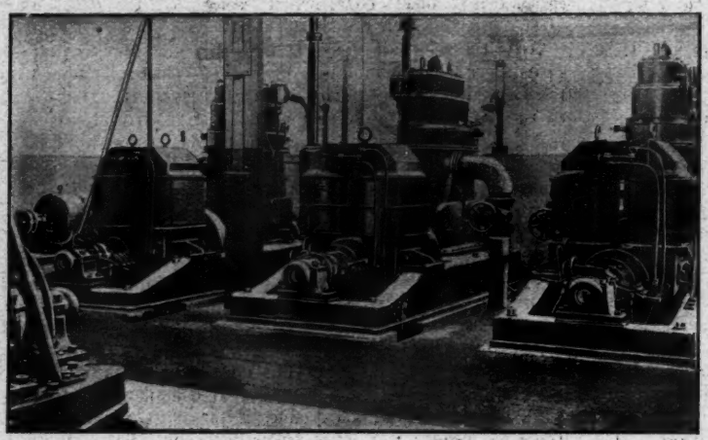
It was also found that the negative charge of the drops increased with the distance through which they fell. In their longer course they naturally picked up a greater number of negative ions.

An interesting result from the meteorological point of view was obtained by making a test after the air had been shut up in the container for several days. The negative charge acquired by the drops was found to be much greater than in ordinary air. Elster and Geitel (*Phys. Zeitschrift*, 2, p. 116, 560, 1901) have shown that enclosed air masses acquire a greater percentage of free ions than free air. This, of course, accounts for the greater negative charge acquired by drops in stagnant air. The presence of moisture was also found to be favourable to the picking-up of negative ions.

These remarkable experiments of Schmauss must be of great value to meteorologists in helping them to form a satisfactory theory of the origin of thunderstorms. Evidently there are at least two great natural processes struggling against each other to create opposite differences of potential between the earth and the atmosphere. For the greater part of the year these processes counteract each other, and prevent a difference of potential from arising which would lead to a disruptive discharge in the form of lightning. But in hot summer weather, when the number of the free ions in the air is increased by the increase of moisture, by stagnant atmospheric conditions, and by the action of the ultra-violet light of the sun, then the Schmauss effect probably gets the upper hand of the Lenard effect, and the negative charge of the earth is so greatly increased, that the electric pressure has to equalise itself in thunderstorms.

A SYDNEY LIGHTING STATION.

The Empire Electric Light Co., of Sydney, made a very small beginning five years ago by purchasing a small 110-volt plant then in use for supplying the electric lighting of the Empire Hotel. Extensions were soon added, and as soon loaded, until it was found necessary to find larger premises; a suitable site was obtained in Margaret Lane, near George Street, having a frontage of 120 ft. and a depth of 100 ft.



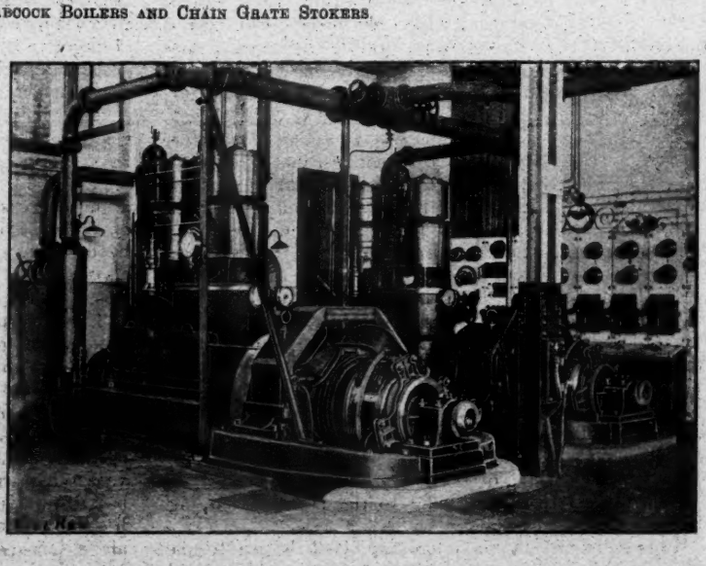
Three 60-kw. Steam Dynamos.

The process of keeping things going at the old station and gradually removing the more modern portion of the plant to the new one, naturally involved a great deal of care and forethought, but was safely carried out without any interruption to the supply under the supervision of Mr. J. R. Woodruffe Gardam, A.M.I.E.E., M.E.V.W., the managing engineer. The new station has been successfully running for some time.

The pressure of supply at the old station was partly 100 volts, three-wire, and partly 200 volts two-wire distribution, but is now entirely 200-volt two-wire. The nature of the area of supply and the use of overhead distribution are not favourable to a three-wire system.

The present lighting of Sydney is practically divided between this company and the Strand Lighting Co., small portions being supplied from the Palace, Oxford, and the recently-erected Imperial stations. The Empire Co. and the Strand Co. have entered into an agreement not to encroach on each other's territory, the area at present supplied by the Empire Co. being about half a mile square, with the station fairly centrally situated.

View of Babcock Boilers and Chain Grate Stokers.



Two 120-kw. Steam Dynamos.

There are at present about 200 consumers connected with an aggregate capacity equal to nearly 14,000 8-c.p. lamps, and including 52 arc lamps and 100 h.p. of motors. The maximum load to date has been about 400 kw.

The station building is of brick, and consists of two storeys; the engine and boiler rooms are on ground floor, and the offices, board room, store room, battery room, workshop and testing room are upstairs. The present building occupies the full frontage, but only utilises 48 ft. of the depth, permitting of considerable extensions. The chimney stack is 110 ft. high, with an internal area of 25 sq. ft. It is lined with fire bricks to a height of 50 ft.

There are four Babcock & Wilcox water-tube boilers, each having an evaporative capacity of 4,200 lbs. of water per hour, with a heating surface of 1,619 sq. ft., and a grate area of 30 sq. ft.; steam is generated at 125 lbs. pressure. The boilers are fitted with chain-grate automatic stokers, electrically driven, and with superheaters of 198 sq. ft. heating surface, capable of raising the temperature of steam an additional 150° F. The feed pumps consist of one Gould pump of a capacity of 15 gallons per minute, direct driven by a Lundell motor; one Waygood pump, also direct connected to a Lundell motor, and capable of delivering 40 gallons per minute, with an auxiliary Blake steam pump as a stand-by, and valves so arranged that any set can be connected as desired. The blow-off, drain, and feed tanks are situated in a cellar beneath the boiler room.

The generating plant is arranged in two rows, on one side being two 120-KW. Parker generators direct-coupled to Alley and McLellan tandem compound non-condensing single-acting high-speed vertical engines, with 11 and 18½-in. cylinders, by 9-in. stroke, running at 300 revolutions. The generators are compound-wound and fitted with equaliser switches for running in parallel.

On the other side are three smaller sets, each consisting of an Alley & McLellan engine, 8½ in. and 14 in. cylinders by 8 in. stroke, direct-coupled to a Parker generator of 60 KW. Steam is supplied to the engines by a ring main.

The battery consists of 115 English Tudor cells, 15 plates each, of 1,000 ampere-hour capacity, and a 30-H.P. Westinghouse booster is provided for charging purposes.

TABLE SHOWING PROGRESS OF SYDNEY LIGHTING.

—	Dec. 31, 1898	June 30, 1899	Dec. 31, 1899	June 30, 1900	Dec. 31, 1900	June 30, 1901	Dec. 31, 1901	June 30, 1902
Number of consumers	13	37	41	51	51	73	95	125
Number of 8-C.P. lamps connected	1,094	2,378	5,386	6,154	6,384	7,536	8,710	11,164
H.P. of motors connected	—	—	—	—	—	23 9	48 04	76
Units generated	17,477	30,935	45,748	94,303	110,863	137,332	175,693	199,327
„ bought	—	429	1,538	4,501	3,964	980	447	18
„ used on works	1,648	1,648	2,873	2,500	3,200	3,822	4,026	5,723
„ lost in distribution and unaccounted for	—	—	—	—	—	6,724	13,823	14,998
„ sold	15,829	29,716	44,413	96,304	111,627	127,766	158,291	178,624

The switchboard is of polished marble bolted to angle-iron framework, and contains five generator panels, battery panel, feeder panel, and station panel for lighting and motors. Each generator panel is provided with automatic overload and reverse current cut-outs of I.T.E. pattern, ammeter and voltmeter, with shunt-regulating resistance arranged horizontally below.

All distributing mains are carried overhead across roofs of buildings.

Charges are by meter, with a sliding scale based on "kilowatts connected," 6d. and 4½d. per unit being charged for lighting, and 4½d. and 3d. for motive power.

THE DIFFICULTIES THAT LECTURERS ON ELECTRICAL ENGINEERING MEET WITH.

BY A UNIVERSITY LECTURER.

THE following is not meant as reply to—nor even meant as a criticism of—the articles contributed by "A Student." It is inspired by one of his concluding remarks, that possibly all professors will disagree with what he has said. I hasten to reassure him. There are many lecturers at any rate (and he probably meant to include them in his term "professor") who will agree with him on many of his main points. But has he thought of the other side of the question; life as a student is proverbially happy, free from care and not too laborious, but what about life as a lecturer? It is not all revelry in *dx dy*, not all the delight of seeing one's name with a long string of letters after it in the calendar, and a short row of figures after it in one's pass-book—if, indeed, the lecturer has a banking account and a pass-book—not all just a mere occasional hour's talk with the students upon a subject with which the lecturer is thoroughly conversant and the student entirely ignorant; not all a successful attempt to entirely muddle the student by arranging a hopeless medley of θ's and ϕ's. There is another side which the student may not see, which the lecturer has to contend with. He has at one time been a student himself, he has a faint recollection of the time when he, too, thought as a student and spoke as a student; memories of the difficulties which he met with as a student often cause him to devote a good deal of time that he would wish for more congenial work to devising methods of enabling his students to overcome those electrical *pontes asinorum*. Though a big man with a long tail after his name, he is still a humble student of Nature—especially human nature—he has still to study the electrical changes and improvements, and worse than all this, if he carry out his work conscientiously, he has often to advise his students. As a lecturer, I would rather give a two-hours' advanced lecture upon a thoroughly practical electrical engineering subject, such as, say, "Central Station Equipment," before an audience of central station chiefs, than give advice to one student.

As all lecturers have their own special methods, so have all students. Moreover, lecturers on electrical engineering are said to be stereotyped; with this I regret that I cannot agree. I divide them into two distinct types, physicists and engineers; but, alas! students are not. Take my own men. For a first year's course I get the youth of 16, who, so says his fond mamma (these mammas are a terrible trial to us poor lecturers) does not know *much* about electrical engineering, but he has often got sparks from a cat's back, and he once attended a lecture at the Town Hall on "Wireless Telegraphy." Parenthetically she murmurs, at fixed intervals, "Please don't let dear Willie work too hard." She knows that he wishes for nothing better than to expire at the earliest possible age, a willing martyr to the alluring goddess Electra, a victim of that relentless Juggernaut, his own ambition, which, she thinks, will finally crush him.

Let us say there are five courses, with laboratory and drawing; Willie was always good at drawing from a child, as probably the decorations inside his text-books eloquently testify! Mamma wishes him to take three courses; he might get hurt in the laboratory—could he put that off for a year? He can do all his drawing at home, so that he does not want that course, and so on, to a length which varies directly as the loquacity of mamma, the patience of the lecturer, and inversely as the manliness of Willie. As a matter of fact, Willie knows nothing of either electricity or engineering; what is far worse, he has his head stuffed with a lot of classical nonsense, which takes no end of hard hitting to get knocked out of him; his knowledge of mathematics—not *dx dy*, but $a + b$—is hopeless, and in two years you have to turn Willie out fit for a gentlemanly post, *i.e.*, he must not mix with common workmen, but be worth a salary greater than your own present one. To-day a degree student in engineering came and asked me if he could take one of the engineering subjects next year, as he very much wished to continue his Greek, and he could not find time for everything. Speech failed me.

The next type—this one is very exasperating—is what I call "the failure." He has been anything from a non-successful medical student to a cattle rancher. He is usually nearly 30, and, having hopelessly failed at everything he has attempted, he "wants to pick up a little electricity"—usually thinks it could be more easily done at a technical school, but thinks that with a year with us he will get a degree. He has read of how Edison started life as a paper boy—or says that he has—and so "his knowledge of the world" (how he dwells on these words, which were probably the cause of his past failures) will always stand him in good stead. He will take the advanced course; can easily read up "the elementary muck" himself. At the end of a year he comes to you to ask what an electrical horse-power is. He will do one thing successfully—demoralise the whole class.

One other type, "the practical man." He has been with a firm, in some cases for three months, in others for as many years. Of course he could set up as a consulting engineer if he wanted to, his "experience" is great enough for that; but he finds that he sometimes gets fogged in his "Wireman's Pocket-Book," and he wants to look up his theory a bit. He has forgotten most of "the stuff" they taught him at school, especially wants to brush up his maths. You advise him to take the first year's course, and he repeats

for your edification his innumerable "practical experiences." In a weak moment you admit him to your advanced course. From that day you are no longer lecturer; you are in the witness-box under the severe cross-examination of the "practical man." You suggest that the lamp you hold in your hand has a resistance of so many ohms, that the motor-generator in the laboratory is built in a certain manner, and you are immediately interrupted with "experiences." Your word is sometimes accepted; if he is in a good humour he is willing to concede that it may be so in this case, "but the way they did it at the works," &c. . . . He is a very great trial, is "the practical man." One of this type once attempted to dogmatise to me upon the advantages of the methods of a workshop where he had had one month in a certain testing department, over that which I recommended. The assurance that I myself had worked as under manager for a whole year with that system, in the very same place where he had subsequently gone as a pupil for a month, had but little effect. Next to "the failure," spare me from "the practical man."

My types of student are as many and varied as the machinery about which I lecture to them. I lay no claim to being more clever than the average student; if I am to do my day's work properly, I must be infinitely more patient. I have tried every method I could think of to make them interested in their work. I have deliberately cultivated their society at social functions so that I may discover where and how the energy which should be put into their work is wasted. I have banished the idea of doing research work which might lead to promotion, that I may take an interest in students' doings and societies; they are invited to bring me their notes, ask for references to text books—everything, and yet I doubt not but that many of them wonder why I am paid a salary, which they think they will command after an elementary course under me. Qualifications of the physicist I hold none; I may be pardoned for claiming the best college training to be obtained in the kingdom, with some years' experience in a responsible position in a large works, so great an admiration for my profession—electrical engineering—that outside of college hours I am loth to talk of it, all these things might still be of no avail to meet the lecturer's difficulties. I reluctantly admit that I still turn out some shockingly bad students; though I have closely studied the art of lecturing, following the advice of an exceedingly clever professor of that subject, I shall always turn out bad students. For every man who takes the full course, and whom I would feel justified in calling an electrical engineer, 10 go away whom I would not trust with any responsibility. The one good man is a great encouragement, the 10 bad ones a crying demand for the immediate action of either the Institution or the Board of Trade to make some sort of official certificate compulsory for the would-be electrical engineer.

It did not need a special lecturer to produce a Dr. John Hopkinson, nor am I aware that Lord Kelvin was more privileged than any of his contemporaries in the courses which he took. Knowledge, which is often the most useful, is that which is discovered by the student himself. Let him remember that, if he take his profession of electrical engineering seriously, he must be a student all his life. A good reader will find a grain of truth in any book—even a text-book. The lecturer is always a student, seldom with anyone to make his path smooth, his road to knowledge easy. He has already experienced, and is even now experiencing, the difficulties that all students, elementary and advanced, of so great a subject as electrical engineering must meet with. It is better, after all, to hammer and forge, by one's own work, oneself into a character, than to be talked into one.

The lecturer has gone over the ground before the student followed the finger-post marked "Electrical Engineering," he can but relate his own impressions of the road along which he, too, probably has met with many difficulties and disappointments. But if he can teach his men manliness, if he can make them earnest students, if he can use his influence upon them (some of them at the most critical period of their life—from 18 to 24 years of age) to show them that there are lessons of life, and of these perseverance is one of the most important; if he can make them deeply interested in one of the greatest and highest professions, for its creed is one of the altruism and the betterment of human conditions of living; if he can produce one such man for every hundred "wasters," then the work of the lecturer, arduous, worrying, and unsatifying though it may be, would yet have been effort well spent, labour not quite in vain.

Lest your student-contributor judge me harshly, I say that, frankly, I admit many of his points. I have learnt at least one thing from his article. For that lesson I, a lecturer but always a student, thank him most sincerely. With him, and with the Editors of this journal, I wish only to promote the cause of real technical training; I wish to point out the lecturer's difficulties, in the hope that possibly a panacea may be suggested.

TESTING, AND OTHER THINGS.

By N. C. WOODFIN.

The art of testing occupies such a large place in electrical engineering, that a short inquiry into its meaning and object may not be without advantage.

The many points of view, such as testing from the standpoint of the manufacturer, owner, operator, consumer, expert, &c., may be divided into two classes, those of maker and user, in one or other of which the less important from time to time appear.

Installations, machines and instruments are tested primarily to ascertain their capability or intrinsic value in relation to the work which they are designed to accomplish. Next in order comes the consideration of efficiency, which includes the mechanical efficiency of machines and apparatus in transforming energy, as the heat of burning coal, into mechanical power, or this again into electrical energy, and that after transmission into its ultimate useful condition. In the case of measuring instruments, for any purpose, these are first examined, or tested, to see that they are in working order, after which the question of finding their efficiency arises.

The efficiency of an instrument may be taken to mean its accuracy; in a very few cases, such as supply meters for very small consumers, and high range recording instruments, notice may be taken of the power consumed in working. The two features named, fitness and efficiency, are found by observation and experiment, thus obtaining numerical data and comparing these with standards.

As it is in this comparison that the desired information is revealed, it is of equal importance that the data obtained be accurate (this can only be in degree, which must be the highest practicable), and that the standards be reliable. One is surprised to notice in electrical works how infrequent is the checking of the instruments commonly used, against standard values, although a reliable standard for the volt unit (which is, perhaps, the most important) is not expensive. Simultaneous readings of volts, amperes and ohms, appear to be uncommon, yet these can be regarded as the only absolutely satisfactory tests, where volt readings are taken against a standard cell, and the resistance measured on a high-class Wheatstone bridge, the circuit being chosen with convenient values and all temperature conditions being carefully noted, notwithstanding that all conductors are of such size as will avoid any heating in the circuit tested; while the current is measured on a balance or other standard recently checked with a voltameter, or whose real relation to the true ampere is accurately known.

By the way, workers with older instruments are interested to hear that a Cardew voltmeter is among those selected for location in the National Physical Laboratory. These voltmeters with their large clock dials and high accuracy are perhaps worthy of more attention; one firm has recently supplied one hundred of them to a certain authority.

But it is of no use attempting to make measurements for finding efficiency until one is assured that a machine or apparatus is capable and in a fit condition for work. A machine is fit for operation, first of all, when it is clean, and next when the instructions provided by the makers have

been complied with. Cleanliness includes dryness, for wet and dirt often go together. Of course, much apparatus has to work out of doors, exposed to the weather, and is designed accordingly. Still, one would think that no reason why a semi-enclosed motor intended for a joiner's shop or a smithy in a shipyard should be left outside, instead of inside a shed, and endure a fortnight's rain before being used. It is not right to say that a machine or apparatus is incapable because it has broken down through the neglect of reasonable precautions and treatment. Capability has always to be determined by experiment, and this to be sound should be made as far as possible in a scientific and methodical manner. Tests made in a hurry are like broken cisterns that can hold no water.

Machinery should always be so placed that what may be termed its vital parts are readily accessible. Some four years ago a certain marine engine works was supplied with an electrical installation, consisting of a three-motor crane, a couple of dozen arc lamps and some other items. Current was obtained from two steam dynamos of about 40 I.H.P. each, located in the corner of a large erecting shop. The switchboard, in a teak frame carrying a slate approximately 3 ft. 6 in. × 5 ft., controlled about 14 circuits, and was foolishly placed between the two generators close against the wall, making the back quite inaccessible without pulling the whole board down. The wiring consisted chiefly of unprotected lead-covered paper-insulated cable, the ends of which were often carelessly exposed to the weather, and frequently badly sealed. One is not surprised to learn that shorts and breakdowns were of frequent occurrence, and that finally other hands were employed to remodel and renew the installation. It was not want of knowledge on the part of the contractor, but contempt of details and lack of method which brought this about.

Since testing is a necessary and important part of the manufacture of electrical apparatus, economy or cheapness is promoted by paying attention to this in design, that is, by so arranging the parts of a machine that testing is easy, both during the making and on completion. It is instructive to observe how this is brought out in up-to-date machines and apparatus, in contrast with those of earlier times. A certain class of indicating wattmeter supplies an illustration. The movable systems in early forms of this were most difficult of access, but later forms are more easily open to testing and examination. One wonders, by the way, that such instruments are not more used for general testing purposes. They could be used as a check on the behaviour of permanent magnet instruments, in which there is now such great faith.

Perhaps a motor-starting switch provides the appliance on which the most ingenuity may be expended, either that it may be the most securely boxed-in and made impossible of repair by any but its maker, who obtains a correspondingly diminished sale, or that it may be understood by anyone in the least possible time. Plain marking of connections and working quantities is of great value, and it may be asked why there is not a more general insistence on all kinds of electrical apparatus being plainly marked with the values for which they are intended?

The wiring contractor is sometimes a sinner in this respect when he removes a maker's name plate from a machine, taking away the figures for its output and number; strangers come and have the expense of special testing in order to find out elementary data which each machine may be expected always to bear upon it. Such actions, done for the purpose of blinding the eyes of the customer, do no one any good, and it may sometimes happen that the firm removing the marks itself meets the cost of the inconvenience afterwards occasioned.

Why cannot all rheostats be plainly marked with their maximum value in ohms—there are scores of cases where this would be most useful?

(To be concluded.)

Worthing.—The T.C. has instructed Mr. Monkhouse to advise on the proposed electric tramway from Worthing to Hove promoted by the B.E.T. Co.

BRITISH ASSOCIATION, BELFAST, 1902.

GRAPHICAL METHOD OF DETERMINING THE DISCHARGE OF A CONDENSER THROUGH A VARIABLE SELF-INDUCTION.

By E. W. Marchant, Lecturer on Electrotechnics at University College, Liverpool.

(Abstract of Paper read before Section A.)

This method is an extension of one described by Dr. Sumpner for determining the rise of current in a circuit with a variable self-induction, to which a P.D. is suddenly applied. The equation of E.M.Fs. in a circuit having a coefficient of self-induction L, capacity C, and resistance R is given by—

$$L\frac{di}{dt} + R\,i + \frac{q}{C} = e,$$

where i is the instantaneous value of the current, and q represents the quantity of electricity on either plate of the condenser at any

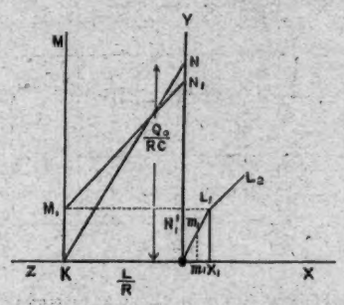


Fig. 1.

instant, and e is the value of the P.D. applied at the same instant.

When the discharge is produced by a spark suddenly passing, the above equation reduces to—

$$L\frac{di}{dt} + R\,i + \frac{q}{C} = 0,$$

with the condition that q at time $0 = v_0 C$ where v_0 is the P.D. between the coatings of the condenser. With an air core induction L is a constant, but with an iron core L is variable and is approximately proportional to $\frac{dB}{dH}$ for a closed iron circuit. Taking the simple case of L constant first, we may write the above

$$\frac{di}{dt} = \frac{-\left(R\,i + \frac{q}{C}\right)}{L}.$$

q at any instant $= Q_0 - \int_0^t i\,dt$, where $Q_0 = v_0 C$.

Q_0 however must be regarded as negative if i is positive when the

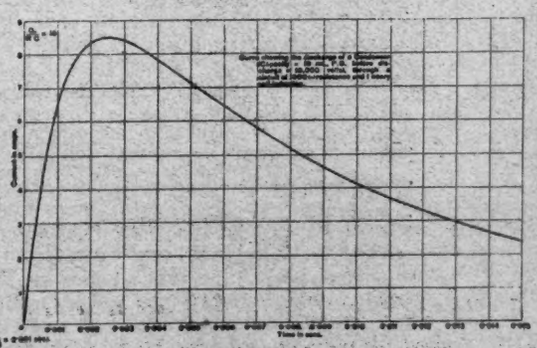


Fig. 2.

current is flowing in such a direction as to discharge the condenser, and we have—

$$\frac{di}{dt} = \frac{\frac{Q_0}{C} - R\,i - \frac{\int i\,dt}{C}}{L} = \frac{\frac{Q_0}{CR} - i - \frac{\int i\,dt}{CR}}{\frac{L}{R}}$$

At time 0

$$\frac{di}{dt} = \frac{\frac{Q_0}{CR}}{\frac{L}{R}}.$$

To draw the discharge curve, let O Y be the axis of current, O X the axis of time (fig. 1).

Take on O N a length $= \frac{Q_0}{R C}$ to the current scale, and on O Z a length $= \frac{L}{R} =$ O K.

Then the slope of K N $= \frac{\frac{Q_0}{R C}}{\frac{L}{R}}$ = initial value of $\frac{di}{dt}$.

Draw, therefore, a short length O L_1 from O parallel to K N.

The problem now is to find the value of $\frac{di}{dt}$ at the time corresponding to x_1. The length of O x_1 should be so chosen that numerically O x_1 in seconds is a simple multiple of R C in seconds.

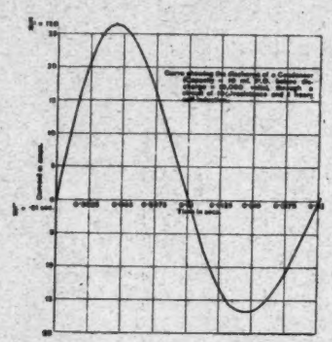


FIG. 3.*

For example, let O $x_1 = \frac{1}{3}$ (R C). O x_1 represents a small time interval dt, and $\therefore dt = \frac{1}{3}$ R C for the small interval we are considering.

Continuing the construction from L_1 draw a line parallel to O Z to meet K M (drawn parallel to O Y) in M_1, cutting O Y in N_1^1. Then

$$N N_1^1 = N O - N_1^1 O = \frac{Q_0}{R C} - i.$$

Draw the mean ordinate $m_1 m_1$ of the area O L_1 x_1,

then $$\int_0^{dt} i\,dt = m_1 m_1 \times O x_1;$$

but O $x_1 = \frac{1}{3}$ (R C) from above, so that

$$\int_0^{dt} i\,dt = m_1 m_1 \times \tfrac{1}{3} R C,$$

and $$\frac{\int_0^{dt} i\,dt}{R C} = \tfrac{1}{3} m_1 m_1.$$

Subtract from N O, therefore, a length N $N_1 = \frac{1}{3} m_1 m_1$.

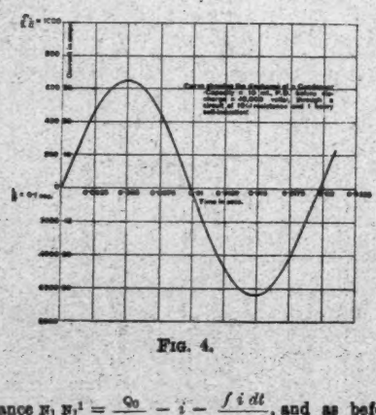


FIG. 4.

The distance $N_1 N_1^1 = \frac{Q_0}{R C} - i - \frac{\int i\,dt}{R C}$, and as before $N_1^1 M_1 = \frac{L}{R}$. The slope of the line from N_1 to M

$$= \frac{\frac{Q_0}{R C} - i - \frac{\int i\,dt}{R C}}{\frac{L}{R}}$$

and is the proper value of $\frac{di}{dt}$ at the time x.

Draw, therefore, a line, $L_1 L_2$ parallel to $N_1 M_1$, of such a length that $x_1 x_2 =$ O x_1. Continuing the process and subtracting successively the mean ordinates of the small trapeziums drawn, a curve of discharge is obtained.

To test the accuracy of the method, discharge curves were plotted for a condenser of 10 mf. capacity with a self-induction of one henry in series with it, for three different resistances in the circuit. The three curves thus drawn are shown in figs. 2, 3 and 4, and were found to be in very close agreement with the theoretical values. The error in determining the time for a complete oscillation did not exceed 0·5 per cent. The method was next applied to the case of a circuit with a variable inductance, the particular example chosen being a coil having an iron core.

The first stage in the process was the determination of the self-induction of the coil for different values of the current. Having obtained a curve showing the relationship between current and self-induction, this was plotted on the left hand side of the figure (fig. 5),

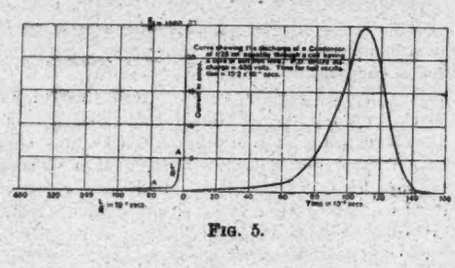


FIG. 5.

the curve taking the place of the straight line K M. The construction adopted is exactly similar to that described above for a fixed self-induction, with the single exception that instead of taking the points M_1 M_2, &c., on the straight line K M, they are taken on the curve which replaces it. This curve, in the case of iron, is different for increasing and decreasing currents on account of the effects due to hysteresis; two curves have therefore to be drawn, the one being used while the current is increasing, the other when the current begins to diminish. A typical curve of discharge is shown in the figure for a condenser of 1·25 mf. capacity, through a coil of small self-induction having an iron core. The distortion of the curve due to hysteresis is well marked, the rate of decrease of current being much more rapid than the rate of increase.

Another effect which is of interest in connection with these curves is that the time for a half oscillation of discharge varies very considerably with the initial voltage. We should expect, therefore, that with a rapidly damped discharge, such as flows through a coil similar to that considered, the time for a half oscillation would not be constant during the whole time occupied by it; in other words, the oscillatory discharge through such a coil would not be isochronous. That this is so was first pointed out experimentally in a letter to *Nature* by the author in August, 1900. The actual graphically determined figures for three voltages are given below.

Voltage.	Time for half oscillation.
9,400	$2{\cdot}9 \times 10^{-5}$
2,350	5×10^{-5}
450	$15{\cdot}2 \times 10^{-5}$

The method described in the above paragraphs is not one which is confined simply to the solution of the problem under consideration; it is applicable to the solution of any differential equation of the second order, in which the coefficients are known functions of the variable quantities. For instance, the determination of the deflection of a ballistic galvanometer, in which the needle has started to move before the whole of the discharge has passed, is an obvious application.

A more useful application, however, is that to the case of a circuit of either fixed or variable induction and with capacity in series, to which a P.D. of known wave form is applied. The shape of the current wave determined in this way should throw considerable light on the sudden rushes of current so often observed when the pressure is suddenly applied to such circuits. It is hoped that some of these results may be worked out and published later.

* In this case R appears to be 100 ω, not 10 ω.—Eds.

TOWN "COUNCILS."

By A. H. M.

One of the most serious difficulties in the way of progress in general, and electrical progress in particular, is undoubtedly the complacently uninformed attitude adopted by many of those members of the community elected to guide the progress, and look after the well being of the town in the capacity of councillors.

No matter how grave the question at issue, whether it be the introduction of a municipal system of electrical tramways, or the purchase of a tract of land to form a playground for generations unborn (or a refuse pitch, as the case may be), the minds of these worthy gentlemen are instantly made up, and their individual decisions for or against the scheme are like the law of the Medes and Persians—unalterable. They recognise no necessity for approaching the measure in an open-minded manner, and of prefacing the consideration of the subject by obtaining reliable data and all possible figures relating to the question; their vote is given in accordance with the mood of the moment, and their uninformed predilections in the matter.

Thus it is that ratepayers are so often saddled with undertakings resulting in a loss instead of the handsome and rate-reducing profits held before their dazzled eyes, which had their true origin in the nebulous haze surrounding the brains of the "councillors."

A truly representative type of this class of "councillor" is the "municipal trams at any price" gentleman, and of these there are not a few; when once their fiat has gone forth in favour of municipal tramways, no facts or figures will move them.

It is even doubtful whether the unbiassed and comprehensive Parliamentary report just issued would cause them to turn a hair; they would probably place it hurriedly in the waste-paper basket, feeling quite convinced that it was a got-up affair for the sole purpose of upsetting their pet scheme.

One of the points which these worthies are utterly unable to comprehend is, that a private company should be anxious to carry out a tramway scheme, whilst at the same time avowing that they are facing the probability of a loss in working for some time to come.

With infinite subtlety they will tell you that this is simply a piece of "bogey" on the part of the company, and that "it won't do."

The writer a few days since heard one of these Solomons in judgment address a most sanguine speech to a number of electors, in which he vigorously informed them that he would personally "guarantee" that the tramways would "pay splendidly." It may be added that it is not within the writer's knowledge that the Solomon in question has deposited a sum of money to back up his "guarantee" in this matter.

These gentlemen will not comprehend the fact that this or that company, with a capital of so many millions sterling, is engaged in carrying out not one, but a large number of such schemes, some of which pay well, others moderately, whilst others may show a loss, but that the average profit earned enables them to pay a satisfactory dividend to their shareholders, and that under such circumstances they are justified in carrying out the scheme in question, in the reasonable expectation of earning a profit in time to come. The figures published in the report referred to showed clearly that, as a whole, such municipal ventures had so far resulted in a loss, and further, that when in the hands of private companies, the average dividend paid was extremely moderate. It may be imagined that such facts as the above would be sufficient to guide the judgment of any ordinary mortal—so they would be—but town councillors are not ordinary mortals.

WASHINGTON, BALTIMORE & ANNAPOLIS SINGLE-PHASE RAILWAY.*

By B. G. Lamme.

The Washington, Baltimore and Annapolis Railway is a new high-speed electric line extending from the suburbs of Washington to Baltimore, a distance of about 31 miles, with a branch from Annapolis Junction to Annapolis, a distance of about 15 miles. The overhead trolley will be used, and schedule speeds of over 40 miles per hour are to be attained. The road is to be the scene of the first commercial operation of an entirely new system of electric traction.

The special feature of this system is the use of single-phase alternating current in generators, transmission lines, trolley car equipment, and motors. It constitutes a wide departure from present types of railway apparatus, and while retaining the best characteristics of the present standard direct-current motor system, the use of alternating current makes it possible to avoid many of the bad features.

The direct-current railway motor is in all cases a series-wound machine. The series motor is normally a variable-field machine, and it is this feature which has adapted the motor especially to railway service. Shunt-wound motors have been tried and abandoned. Induction motors do not possess the variable-field feature at all, as they are essentially constant-field machines.

The variable field of the series motor makes it automatically adjustable for load and speed conditions. It also enables the series motor to develop large torques without proportionately increased currents. The automatically varying field is accompanied by corresponding variations in the counter-electromotive force of the armature until the speed can adjust itself to the new field conditions. This feature is of great assistance in reducing current fluctuations with a small number of steps in the regulating rheostat. Any increase in current, as resistance is cut out, is accompanied by a momentary increase in the counter-electromotive force, thus limiting the current increase to a less value than in the case of a constant-field motor.

Next to the type of motor, the greatest advantage possessed by the direct-current system lies in the use of a single current or circuit, thus permitting the use of one trolley wire. For third-rail construction, the use of single current is of even greater importance than in the case of the overhead trolley.

Some of the undesirable features of the direct-current railway system should also be considered. A nominally constant voltage is supplied to the car, and speed control is obtained by the use of resistance in series with the motors, with a loss proportional to the voltage taken up by the resistance. By means of the series-parallel arrangement, the equivalent of two voltages is obtainable at the motor terminals without the use of resistance. Therefore, with series-parallel control, there are two efficient speeds with any given torque. For heavy railroad service, where operation for long periods at other than full and half speeds may be necessary, the rheostatic loss will be a very serious matter.

The controlling devices themselves are also a source of trouble.

Another limitation of the direct-current system is the trolley voltage. The maximum permissible trolley voltage is dependent upon inherent limitations in the design of motors and controllers. The disadvantages of low voltage appear in the extra cost of copper and in the difficulty of collecting current. In heavy railroad work the current to be handled becomes enormous at usual voltages. A 2,400-h.p. electric locomotive, for example, will require between 3,000 and 4,000 amperes at normal rated power, and probably 6,000 to 8,000 amperes at times. With the overhead trolley these currents are too heavy to be collected in the ordinary manner. It is evident that for heavy service a much higher voltage is essential.

A further disadvantage of the direct-current system is the destructive action known as electrolysis. This may not be of great importance in interurban lines, but in city work its dangers are well known.

From the above statements it is evident that an alternating-current railway system should possess the two principal features of the direct-current system—viz., a single supply circuit and the variable-field motor, and to be an improvement upon the direct-current system, the alternating current should avoid some of the more important disadvantages incident to the present direct-current railway apparatus.

The system must, therefore, be single-phase. The polyphase railway system used on a few European roads employs three conductors, and therefore does not meet the above requirement.

The motor for the alternating-current railway service should have the variable-speed characteristics of the series direct-current motor. The polyphase motor is not suitable, as it is essentially a constant-field machine, and does not possess any true variable-speed characteristics. Therefore it lacks both of the good features of the direct-current railway system. A new type of motor must therefore be furnished, as none of the alternating-current motors in commercial use is adapted for the speed and torque requirements of first-class railway service.

The direct-current limits of voltage are at once removed, as transformers can be used for changing from any desired trolley voltage to any convenient motor voltage. Electrolysis troubles practically disappear. As transformers can be used, variations in supply voltage are easily obtainable. As the motor is assumed to have the characteristics of the direct-current series motor, speed control without rheostatic loss is practicable when voltage control is obtained. This combination, therefore, allows the motor to operate at relatively good efficiency at any speed within the range of voltage obtained. If the voltage be varied over a sufficiently wide range, the speed range may be carried from the maximum desired down to zero, and, therefore, down to starting conditions. With such an arrangement no rheostat need be used under any conditions, and the lower the speed at which the motor is operated, the less the power required from the line. The least power is required at start, as the motor is doing no work, and there is no rheostatic loss. The losses at start are only those in the motor and transforming apparatus, the total being less than when running at full speed with an equal torque. Such a system, therefore, permits maximum economy in power consumed by motor and control.

The use of alternating current on the car allows voltage control to be obtained in several ways. In one method a transformer is arranged with a large number of leads carried to a dial or controller drum. The Stillwell regulator is a well-known example of this type of voltage control. This method of regulation is suitable for small equipments with moderate currents to be handled. The controller will be subject to some sparking, as in the case of the direct-current apparatus, and therefore becomes less satisfactory as the car equipment is increased in capacity. Another method of control available with alternating current is entirely non-sparking, there being no make-and-break contacts. This controller is the so-called "induction regulator," which is a transformer with the primary and secondary windings on separate cores. The voltage in the secondary winding is varied by shifting its angular position in relation to the primary. With this type of voltage controller very large currents can be handled, and it is especially suitable for heavy equipments, such as locomotives.

It is thus seen that there is one method of control available with alternating current which avoids the inherent troubles of the direct-current controller. The induction regulator is primarily a transformer, and all wear and tear is confined to the supports which carry the rotor. This ideal type of controller is not applicable to the polyphase railway motor, in which speed control can be obtained only through rheostatic loss. The polyphase control system is even more complicated than the direct-current, as there must be a rheostat for each motor, and two or three circuits in each rheostat. It is thus apparent that, by the use of single-phase alternating current with an alternating-current motor, having the characteristics of the direct-current series motor, the best features of the direct-current system can be obtained, and, at the same time, many of its disadvantages can be avoided.

There are several types of single-phase motors which have the series characteristics. One type is similar in general construction to a direct-current motor, but with its magnetic circuit laminated throughout, and with such proportions that it can successfully commutate alternating current. Such a motor is a plain series motor, can be operated on either alternating or direct current,

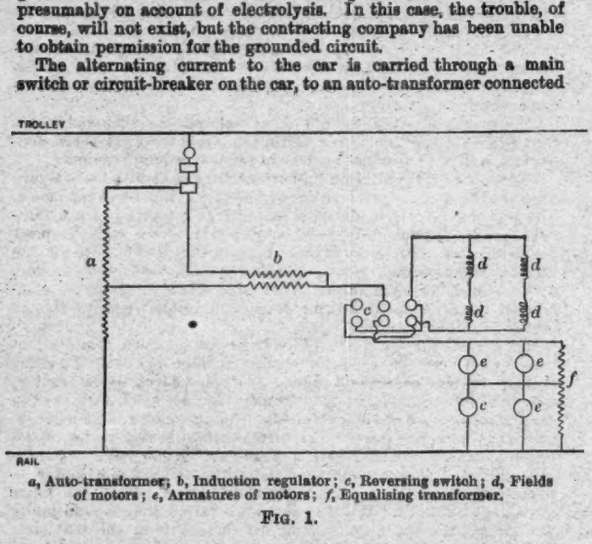
* Abstract of a paper read before the American Institute of Electrical Engineers, September 26th, 1902.

and will have the same torque characteristics in either case. Another type of motor is similar in general construction to the above, but the circuits are arranged in a different manner. The field is connected directly across the supply circuit, with proper control appliances in series with it. The armature is short-circuited on itself across the brushes, and the brushes are set at an angle of approximately 45° from the ordinary neutral point. The first of these two types of motors is the one best adapted for operation in large units.

This is the type of motor which is to be used on the Washington, Baltimore & Annapolis Railway. Several motors have been built and tested with very satisfactory results, both on the testing stand and under a car. The results were so favourable that the system was proposed to the Cleveland Engineering Co., representing the Washington, Baltimore & Annapolis Railway, and after investigation by its engineers, it was adopted. A description of the apparatus to be used on this road will illustrate the system to good advantage.

Single-phase alternating current will be supplied to the car at a frequency of $16\frac{2}{3}$ cycles per second, or 2,000 alternations per minute. The current from the overhead trolley wire is normally fed in by one trolley at approximately 1,000 volts. Within the limits of the district of Columbia two trolleys are employed, as by Act of Congress the use of rails as conductors is prohibited in this district, presumably on account of electrolysis. In this case, the trouble, of course, will not exist, but the contracting company has been unable to obtain permission for the grounded circuit.

The alternating current to the car is carried through a main switch or circuit-breaker on the car, to an auto-transformer connected



a, Auto-transformer; *b*, Induction regulator; *c*, Reversing switch; *d*, Fields of motors; *e*, Armatures of motors; *f*, Equalising transformer.

FIG. 1.

between the trolley and the return circuit. At approximately 300 volts from the ground terminal a lead is brought out from the auto-transformer and passes through the regulator to one terminal of the motors. For starting and controlling the speed an induction regulator is used, with its secondary winding in series with the motors. This secondary circuit of the regulator can be made either to add to or subtract from the transformer voltage, thus raising or lowering the voltage supplied to the motors. The regulator therefore does double duty. The controller for direct-current motors merely lowers the voltage supplied to the motors but cannot raise it, but an alternating-current regulator can be connected for an intermediate voltage, and can either raise or lower the motor voltage. In this way the regulator can be made relatively small, as it handles only the variable element of the voltage, and the maximum voltage in the secondary winding is but half of the total variation required.

In the equipments in question, the range of voltage at the motor is to be varied approximately 200 volts up to 400 volts, or slightly higher. The transformer on the car will supply 315 volts, and the secondary circuit of the regulator will be wound to generate slightly more than 100 volts when turned to the position of its maximum voltage. This voltage of the regulator is about one-fourth of that of the motors at full voltage. The regulator can consequently be made relatively small, in comparison with the motor capacity of the equipment. It has been found unnecessary to use much lower than 200 volts in this installation, as this voltage allows a comparatively low running speed, and approximately 200 volts will be necessary to start with the required torque. The greater part of this voltage is necessary to overcome the electromotive force of self-induction in the motor windings, which is dependent upon the current through the motor and is independent of the speed of the armature.

There will be four motors of 100 H.P. on each car. The full rated voltage of each motor is approximately 220 volts. The motors are arranged in two pairs, each consisting of two armatures in series and two fields in series, and the two pairs are connected in parallel. The motors are connected permanently in this manner. Since voltage control is used, there is no necessity for series parallel operation, as with direct-current motors. To ensure equal voltage to the armatures in series, a balancing or equalising action is obtained by the use of a small auto-transformer connected permanently across the two armatures in series, with its middle point connected between them. The fields are arranged in two pairs, with two fields in series and two pairs in parallel. This, therefore, parallels the fields independently of the armatures, which was formerly the practice with direct-current motors. It was a defective arrangement with such motors, as equal currents in the field did not ensure equal field strengths in the motors, and the armatures connected in parallel, therefore, would be operating in fields of unequal strength, with unequal armature currents as a direct result. With alternating currents in the fields the case is different. The voltage across the fields is dependent upon the field strengths, and the current supplied to the fields naturally divides itself for equal magnetic strengths. The chief advantage in paralleling the fields and armatures independently is that one reversing switch may serve for the four motors and one balancing transformer may be used across the two pairs of armatures. The ordinary direct-current arrangement of armatures in series with their own fields can be used, with a greater number of switches and connections.

The general arrangement of the auto-transformer, regulator, motors, &c., is shown in fig. 1.

The induction regulator or controller resembles an induction motor in general appearance and construction. The primary winding is placed on the rotor, and the secondary or low voltage winding on the stator. The motor also has a second winding which is permanently short-circuited on itself. The function of this short-circuited winding is to neutralise the self-induction of the secondary winding as it passes from the magnetic influence of the primary. The regulator is wound for two poles, and therefore is rotated through 180° in producing the full range of voltage for the motors. One end of the primary winding of the regulator is connected to the trolley, and the other to a point between the regulator and the motors. It thus receives a variable voltage as the controller is rotated. There are several advantages in this arrangement of the primary in this particular case. First, the regulator is worked at a higher induction at start, and at lower induction when running, the running position being used in these equipments for much longer periods than are required for starting. Second, when the motors are operating at full voltage the current in the primary of the regulator passes through the motors but not through the auto-transformer or the secondary of the regulator. This allows considerable reduction in the size of the auto-transformer and regulator.

(To be concluded.)

CORRESPONDENCE.

Tramcar Brakes.

I have read with much interest the article by Mr. H. B. Phillimore in the current number of the ELECTRICAL REVIEW. Having had some fair amount of experience in the testing of electric car brakes, I feel that I should like to make a few comments upon this article, and I propose to deal with the last paragraph :—

"One portion of the equipment . . . . as easy as driving on the level."

Mr. Phillimore writes as if there were only one form of track brake, more commonly spoken of, perhaps, as the slipper brake. I take it that the brake he mentions is of the Spencer type. Cars fitted with brakes of this type have been repeatedly tested, and an expert driver can apply the brake in about 10 seconds, using both hands; 10 seconds is much too long an interval. At a speed of, say, 20 miles an hour, this would correspond to a space of rather over 290 ft., or, say, about 12 car lengths; and this would be traversed before retardation commenced. Therefore I agree with Mr. Phillimore that, as an emergency brake, it is of no use.

I next read the statement, "also most of the track-brakes used in this country will not stop a car on a steep hill."

The Spencer brake, when *once* applied, will control a car very fairly on a hill of 1 in 11.

There is another form of slipper brake which I have repeatedly tested, in which the slipper block is applied to the rail by means of compressed air actuating a piston, the pressure being intensified by means of a toggle system of levers. This brake is, as yet, comparatively a recent introduction. However, I have seen it advertised in your journal, and the agents are Messrs. Estler Bros.

This brake is applied by the simple motion of an air-valve handle, and the motion is performed with the right hand, the limits of motion, for full open, being a quarter-turn.

When applied suddenly on a sanded rail on the gradient mentioned above, a car of Messrs. Dick, Kerr & Co.'s manufacture, 6 ft. wheel-base, double-decked type, weight, I suppose, about 8—9 tons, was pulled up in rather under two car-lengths, the speed being the maximum attainable with a "full parallel" start at the top, and about 440 yards

of the incline traversed. This brake would not only pull the car to a stand as stated, but would hold it stationary for any desired (reasonable) length of time.

I totally disagree with the author's statement that the track-brake should be applied at the top of the hill and left alone till the bottom is reached. The slipper which bears on the rail should be a wood block, and is usually 15 in. to 18 in. long. If used in this way the shoes would speedily be worn away, and renewal would be necessary either every day or every other day, according to the stress of service.

Managers of tramway systems frequently impose penalties on drivers who use their slipper brakes in cases other than those of emergency. Metal slippers have been tried, but are not nearly as effective as the wood ones, though, of course, they are much more durable.

All the drivers (not novices of three or four weeks' standing) that I have come across, experience no difficulty in descending a hill using the hand brake only, and they find they can do this without skidding the wheels, and consequent production of flats. Besides, a driver is rendered confident by the knowledge that he can always stop in case of his hand brake failing him, by means of his air brake (when that is fitted to his car).

Mr. Phillimore's paper is of great interest, and his remarks are very convincing, taking them as a whole.

I should be glad to see this article followed by others of a similar character by other writers.

W. Arnold Ogden.

University College, London, W.C.
October 11*th*, 1902.

[The pneumatic brake in question (Hewitt & Rhodes) was described in our issue of November 15th, 1901. We shall be glad if other readers who have had practical experience with different kinds of car brakes will communicate with us on this very important matter.—EDS. ELEC. REV.]

Double-Current Generators and Rotary Converters.

In your issue of October 3rd, there appears a very able article on "Double-Current Generators and Rotary Converters," by S. Woodfield. This reviews the best practice on these machines, and is worthy of careful reading. There is one point I should like to take exception to, however; the author recommends installing the induction regulator on the high tension side of the system, whereas I consider that it is decidedly preferable to instal it on the low tension side. The design of an induction regulator for high voltage involves a bulky and expensive piece of apparatus, which also has the disadvantage of having poorer constants than one designed for low pressure. The right place for an induction regulator is between the step-down transformer and the rotary, and, in actual cases, this is the place in which it will be found that it has been installed.

H. S. Meyer.

Joule's Work.

I should be much obliged if any of your readers could, through the medium of the columns of your valuable paper, gives me the names of any works dealing with the results upon practical work of the quantitative determination by Joule of the relation of heat to work.

Phos.

Electric Train Lighting.

Noticing an article on the "Electric Lighting of Trains in Germany" in your last issue, I think, perhaps, the following short description of a system in use in the U.S.A. of lighting some heavy overland trains might be of interest to some of your readers:—

The trains to which the following description refers run daily between San Francisco and Chicago, covering the 2,335 miles in about 70 hours; the longest stop made on the run is about an hour, the average stops being about 10 or 20 minutes. The Overland, Limited, is a solid vestibuled train, consisting of two baggage cars, buffet composite car, drawing-room sleeping car, compartment observation car, and dining car; it is, of course, electrically lighted throughout.

The generating plant consists of a small direct-coupled engine and dynamo placed in the forward baggage car, which is next the locomotive, together with a battery of accumulators and a small switchboard. The engine is fed with steam from the locomotive by a flexible coupling, which can readily be disconnected and connected when changing locomotives; the generating plant runs continuously, except during the few minutes occupied in changing engines, when it necessarily must be shut down, the lighting being maintained during these few minutes by the battery. The time occupied in changing locomotives is so short, and it is done so rarely, that the capacity of the battery can be very small.

The above system offers several advantages over other systems of electric train lighting, especially in the case of long runs; all the electrical plant being together, and being easily accessible at all times, can be kept in good order, and as an electrician is always carried, whose only duty is the care of the lighting plant, the electric lighting can be made most reliable and economical.

W. P. Burke.

Mains.

Amongst the many ways of running mains, there is one method I have not seen yet. It is to lay the mains in troughs, as in the case of the solid system, but without any filling. This method should be useful for feeders, as the mains would not be damaged in the laying in, as they are apt to be when they are pulled in. Furthermore, it would be possible at a later date, to pull the feeders out and to draw in larger ones. It would also be possible to lay the system in the first case without any draw-in boxes, but if the feeders had to be replaced some years later, draw-in boxes could then be fitted. On the other hand, should it happen that the feeders did not ever require removing, the cost of the draw-in boxes would be saved.

C. Turnbull.

North Shields, *October* 14*th*, 1902.

A SURVEY OF ELECTRICAL PATENTS GRANTED IN THE UNITED STATES.

In a former issue (October 3rd, 1902) we called attention to the great labour expended in the United States in connection with the taking of the Twelfth Census upon the collection of information regarding manufactures of that country, and we were able to give then a brief abstract of a long report upon the electrical industry. In view of the current belief in America that much of the industrial progress of that country is due to the system of patent law in vogue, it is not surprising to find that in this recent thorough investigation patents were not forgotten, and we have now to notice briefly a report on "Patents in Relation to Manufacturers," prepared by Mr. Story B. Ladd, under the direction of Mr. S. N. D. North, chief statistician for manufactures for the Twelfth Census. We are only concerned with the electrical patents, and as an abstract of that portion has been published by our American contemporary, the *Western Electrician* (of September 13th, 1902), we have not hesitated to make use of its good work in what follows.

The four principal classes of patents are those dealing with (1) generation of electricity; (2) electric lighting; (3) motive power; and (4) electric traction. We shall glance at each class in turn, and need only say by way of preface, that the reader should bear in mind we are only dealing with American patents, so that the names attached to particular inventions in some cases may not be those usually given for the same inventions in this country.

Generation of Electricity.—During the period covered by the official report, 3,688 patents were issued in this class. The earliest patent on the subject (Sonnenburg and Rechten, No. 8,843, March 30th, 1852) describes a machine for killing whales by electricity; but within a few years inventions of a much more practical character began to appear, and on August 19th, 1856, Shepard was granted a patent, No. 15,596, for an early form of dynamo with permanent field magnets, which was used to some extent in later years for coast lighting. Ten years later Wilde (patent No. 59,738, November 13th, 1866), invented a machine intermediate between those with permanent magnets and those with electro-magnets excited by the current generated by the

dynamo itself. From that date rapid progress was made, and before many years had passed the dynamo had received most of the features prominent in its present form. The continuous armature winding was introduced to the United States in the patent of Gramme and d'Ivernois, No. 120,057, October 17th, 1871. Weston's patent No. 180,082, July 18th, 1876, introduced a multi-polar self-exciting dynamo, while the first machine of the modern form with consequent poles was patented by Holcombe, No. 184,966, December 5th, 1876. Two years later, on October 29th, 1878, Weston made one step further with patent No. 209,532 for a machine which, besides having consequent poles, had a cylindrical ventilated armature and continuous winding. Up to this time the field-magnet winding of all machines was in series with the load, so that when the machine was on open circuit the magnets had no excitation, but on July 22nd, 1879, Brush received a patent (No. 217,677) for a high-resistance winding on the field-magnets in shunt across the load, so that excitation was obtained on open circuit. In the following year the same inventor patented a regulator consisting of a shunt around the field-magnets, including a variable resistance (No. 224,511, February 17th, 1880). About the same time various modifications of the armature were introduced in different patents, but these need not be specially noticed. A more important patent is that of Von Hefner-Alteneck, No. 234,353, November 9th, 1880, which disclosed a multi-polar alternating-current machine having a portion of its current commutated and used to excite the magnets. In the list for 1882 there appears the name of an inventor who takes a high place among the pioneers of electrical engineering. This is Van Depoele, who appears on this occasion in patent No. 257,990, May 16th, 1880, as the inventor of a motor-generator with two armature windings, one taking current and driving the machine as a motor, the other thereupon acting as a generator. The same inventor in 1890 introduced the carbon brushes in patent No. 422,265, February 25th, 1890. Two years earlier, on February 14th, 1888, a patent was granted to Eickemeyer for a drum armature winding consisting of coils separately wound and fixed on the core (No. 377,996).

Since 1890 there have, of course, been many patents for dynamos or improvements therein, but by that year generators had received practically all their modern features, and what has since been done has been more in the way of perfecting details, such as prevention of sparking at commutators, and so on.

The number of patents dealing with transformers is, of course, considerable, but we need only mention here the famous Gaulard and Gibbs invention (No. 351,589, October 26th, 1886), which led to the practical use of transformers in systems of distribution, especially after Rankin Kennedy and Stanley had shown how to obtain self-regulation of the transformers when connected in parallel across the mains.

Electric Lighting.—This is the largest of the four classes of patents now under consideration, and contains 5,833 patents. The art of electric lighting may be said to have commenced with the introduction of the incandescent lamp by Edison in 1880 (No. 223,898, January 27th), but before that date there were several patents dealing with arc lighting, as, for example, a patent by Brush, No. 212,183, February 11th, 1879, for a main and shunt magnetic differential feed for arc lights. The real impetus, however, was given by the incandescent light, and from 1880 progress was rapid. Many of the patents are concerned with the manufacture of these lamps, and in this connection mention may be made of Maxim's patent, No. 405,170, June 11th, 1889, for standardising filaments by heating them electrically in hydro-carbon vapour. What is known as the "three-wire system" of distribution is in this country associated with the name of John Hopkinson, but in the American list it appears under the name of Edison in Patent No. 274,290, March 20th, 1883. In a few years after that date electric lighting by incandescent lamps had reached a high state of perfection, but since then improvements in details have been steadily made. Alongside these inventions have come others introducing novelties in lighting, departures from the old form of incandescent lamp. The most noteworthy of these is the Nernst lamp (U.S.A. patents Nos. 623,811, 685,725, 685,732), a lineal descendant of the old Jablochkoff candle, and based on the fact that certain oxides of the rarer earths become electrolytic conductors when heated, the resistance decreasing with rise of temperature. In this class of lights there are 50 patents. Another new class is represented by the Cooper-Hewitt lamp (Patent No. 682,690), which has been fully described in former issues of the Electrical Review. In arc lighting there have recently been some novelties introduced, such as the Bremer arc lamp (Patents Nos. 658,423, 679,877, 679,878, 684,407, 697,439), which gives an improved light by the introduction of salts of alkaline metals into the carbons. When first tried, this device was found to cause flickering of the light; but Bremer discovered that the flickering was cured by the addition of still more of the alkaline salts to the carbon.

The list of patents on electric lighting contains several inventions for the lighting of trains by power derived from the motion of the train.

Motive Power.—This is the smallest of the four classes, and contains 2,031 patents. Most of the development in the distribution and use of electricity for motive power is of quite recent date, especially in alternate current working. The following patents are given as illustrative of the growth of this art:—

Thomson, May 17th, 1887, No. 363,186;
Tesla, May 1st, 1888, No. 381,968;
Thomson and Wightman, March 19th, 1889, No. 399,801;
Zipernowsky and Deri, August 5th, 1890, No. 433,758;
Von Dolivo-Dobrowolsky, July 7th, 1891, No. 455,683;
Siemens, September 5th, 1893, No. 504,630;
Hunting, February 20th, 1894, No. 514,933;
Scott, June 5th, 1894, No. 521,051.

As transmission in America is mostly done by overhead wires, much attention has been paid by inventors to the perfection of the line and its adjuncts, especially the insulators. A method of making high tension insulators in sections, which are afterwards secured together by a fusible glaze, is patented by Boch, No. 600,475, March 8th, 1898.

Of recent years there have been many attempts to use "wireless telegraphy" for the transmission of energy for motive power, perhaps the best known being Tesla's adaptation to the control of torpedo boats (No. 613,809, November 8th, 1898).

As regards motors, patents are too numerous to have other than general mention. During the last few years many patents have been issued for starting devices (*e.g.*, Burke, No. 611,558, September 27th, 1898), for changing motor connections from series to parallel or combinations of series and parallel (*e.g.*, Knight, No. 587,442, August 3rd, 1897), and for other important improvements in practical working. Among the modern uses of motors, the electric elevator now may perhaps claim to be the most popular, and patents in connection with such apparatus are very common. As early as 1885 we find in Wheeler's patent (No. 324,621, June 23rd, 1885) elevators described having motors stationary and automatically controlled by switches on the moving car.

Electric Traction. — Electric railways have not yet reached perfection to the same extent as electric lighting, and there is still a good field here for inventors. The patent lists show that many are ready to devote much time and ingenuity to this subject. The art of electric traction was practically unknown in 1880, yet this class contains 2,947 patents. In the early "eighties" we find several patents for overhead systems with trailing trolleys, one to Finney (January 2nd, 1883, No. 270,186), having both direct and return conductors overhead and using a double trolley, and another to the same inventor in the same year (September 18th, 1883, No. 285,353), showing the ground return. Then came the upward spring-pressed trolley invented by Van Depoele (December 4th, 1888, No. 394,038, and January 19th, 1892, No. 467,448). But the overhead system did not receive the undivided attention of inventors, for almost simultaneously with the above inventions there appeared others dealing with conduit systems. Thus in 1884 (September 23rd, No. 305,731) Knight's patent disclosed a system using an underground conductor with slotted conduit, and in the following year another system with an underground conductor and contacts projecting

above the surface of the ground was patented by Painter (June 23rd, 1885, No. 320,679).

In rail-bonding Daniels in 1899 took out his patent, No. 582,849, for a bond made by hot pressure, while in 1900 McTighe, in patent No. 650,861, protected his process for bonding by cold welding.

Among systems of distribution of current to electric railroads we may notice that of Heilmann (No. 622,466, April 4th, 1899), which provides local generators for separate sections of the track, these generators being themselves driven from a central power station, and that of Westinghouse (No. 645,613, March 20th, 1900), which makes use of producer gas as well as of electricity. In this system gas is generated at a central station and distributed to local stations to run gas engines there, which in turn supply the driving power for the electric generators. In the systems for the running and control of the trains the best known is the Sprague multiple-unit system, Patent No. 660,065, October 16th, 1900.

This is but a brief outline of four of the most important classes of electrical patents. In a later number we shall continue our survey, considering other branches of the electrical industry, such as telegraphy and telephony.

(*To be continued.*)

THE CONTINENTAL ELECTRICAL INDUSTRY.

The German Crisis Affecting Other Countries.

The spirit of enterprise in Germany is not dead, notwithstanding the crisis through which the electrical industry is passing. During the first six months of 1902 four new companies were formed, with a combined capital of £470,500, as compared with five companies and a capital of £197,000 in the corresponding period of 1901. Since then, various concerns have been registered, one being the Pfluger Accumulator Co., of Berlin, which has been formed, with a capital of £70,000, to acquire the secondary battery business carried on in that city by Dr. Pfluger. In this connection, some alarm has been manifested in consequence of the owners of the German lead ore mines and works advocating the imposition of a duty on lead ore and lead to the extent of £5 per ton and £7 10s. per ton respectively. It is considered that such high duties would cripple the export trade in secondary batteries and cables, but there is little reason for supposing that the native lead producers will secure any aid from the Government now that the Tariff Bill has undergone second reading at the hands of the Committee of the Federal Council. Whether the Bill will pass through the Reichstag is, however, quite another matter.

Switzerland has also formulated a new tariff, which proposes higher duties than those now obtaining, but this mainly affects Germany, which does not regard the scheme with favour. The leading Swiss engineering firms and the Association of Swiss Electrical Engineers have appointed a committee to investigate the question of electric traction on the railways, M. E. Tissot, of Basle, being chairman of the committee. In addition to this, the Neuhausen Aluminium Co. is now continuing, on a large scale, the experiments which were started a short time ago, with the object of extracting steel direct from ore or old iron. The company has secured a license to work the process from M. Heroult, the French inventor, and the trials are being conducted at the Rheinfelden works.

Teutonic Companies.

The severe check experienced a year ago by the Helios Co., of Cologne, which has an ordinary share capital of £1,000,000, and a bond issue amounting to £770,500, became accentuated during the financial year ended June 30th last. Having paid dividends of 12 per cent. in 1896, 11 per cent. in 1897 and 1898, and 7 per cent. in 1899, the company closed the year 1900—1901 with a deficit of £245,320, after having absorbed a large portion of the reserve fund, whilst for 1901—1902 the debit balance has been increased to no less than £442,654, so that nearly one-half of the share capital has now been lost. The heavy loss of £197,334 is accounted for, among other causes, by the necessity for writing off £112,600 for the depreciation of investments, syndicate business and bad debts; £18,595 has been expended on foreign organisation, £19,184 has been paid as bank interest and for discounting, and £25,553 as interest guarantees. It appears from the company's report that the gross profits from manufacturing and sales, which in the previous year fell to £23,197, rose to £42,540 last year, whilst the general expenses declined during the same period from £51,318 to £36,576. The report states that owing to increased competition greater exertions were necessary during the year, but the company succeeded in maintaining the activity of the works at least at the level of the preceding year, although mostly at depressed prices and correspondingly small profits. According to the opinion of customers and the results of the Düsseldorf Exhibition, confidence in the technical capabilities of the undertaking has been restored, but the directors point out that in order to be successful the financial capacity must also be placed beyond question, and with this object in view they propose that the company should disassociate itself from investment and allied business, and limit its operations solely to that of a manufacturing firm. Too much space would be occupied in detailing the somewhat complicated scheme of re-organisation of the company's finances, as suggested by the directors. It will, however, suffice to say that the plan consists in an exchange of shares with the company's trust—the Company for Electrical Investments, of Cologne—the reduction of a large portion of the ordinary shares in the ratio of 4 to 1, the conversion of other ordinary into preference shares upon which additional payments are to be made, the issue of further preference capital and a reduction in the amount of the bonds. If this drastic scheme is carried into effect in its entirety, the deficit would be wiped out and the company have £200,000 available in cash; the capital would then amount to £625,000 in preference shares, and £140,000 in ordinary shares, together with a bond debt of £587,000.

The shareholders in the German Cable Works Co., of Berlin and Rummelsburg, were informed at the recent annual meeting that the position of business is suffering from the unfavourable conditions still existing, but that the future is looked forward to hopefully, as the undertaking is working more advantageously. The report adopted by the meeting shows that a loss of £6,450 was incurred during 1901-1902, as compared with a working profit of £33,258 in the previous year, when a dividend was paid at the rate of 4 per cent. out of the net profits of £4,682. After absorbing the reserve fund and providing for depreciation, the accounts for the past year close with a deficit amounting to £6,640. The report attributes the loss to the unexpected and heavy fall in the prices of materials, the reduction in the stock of manufactures and the downward movement in sale prices owing to the large diminution in the demand. It is pointed out that the "consumption" of cables throughout Germany during the year was only one-third of the quantity obtaining in the preceding 12 months, but that if there is no repetition of the variation in the prices of materials, a gradual improvement in the cable industry may be expected to take place.

The Mannheim enterprise of Brown, Boveri & Co. is the German branch of the parent establishment at Baden, Switzerland, and similarly to the latter, it has suffered from the depression in prices during 1901, and at the same time has incurred additional expenses by the opening of offices in various large towns. Having a nominal capital of £300,000, of which one-half has been paid, the Mannheim Co. only realised a net profit of £6,263 during 1901—1902, as compared with £17,040 in the preceding year. It is proposed to distribute 4 per cent. for the year, being a decline to the extent of 6 per cent. The company has become interested in the Turbinia (Parsons Patents) Co. for the promotion of the Parsons turbine in Germany for use on ships. The number of workmen employed has been gradually reduced since the winter, and shorter shifts have also been temporarily introduced.

The Rheydt Cable Works Co., of Rheydt, is in the happy position of having made substantial progress during 1901—1902, inasmuch as it has been able to increase the dividend of 8 per cent., which was distributed in the previous year, to 10 per cent. on the higher capital of £58,000. It appears from the report of the directors that all departments were employed during the year, and besides making further extensions, the power plant was doubled. The net profits amounted to £8,750, as compared with £6,513. The report characterises the results as corresponding to expectations, and it expresses the hope that, notwithstanding the difficult course of business, an equally favourable return will be possible for the present year.

The Telephone (Berliner) Works Co., of Hanover, has just held an extraordinary meeting, when a resolution was adopted deciding to increase the share capital from £75,000 to £100,000. It appears from statements made to the shareholders that although the final figures concerning the year 1901—1902 are not yet available, the provisional results show that the directors will be unable to recommend any dividend for the year. This unsatisfactory position, which compares with a 9 per cent. distribution for 1900—1901, is attributed partly to a diminution in the income and partly to direct losses incurred by the foreign branch. It is considered indispensable in the interests of the further development of the undertaking and the severity of competition due to the unfavourable situation of trade that new markets should be opened up, and the considerable expense devoted to this purpose during the past year has been keenly experienced, whilst benefits will only be derived therefrom in future years. The directors are therefore of opinion that the unsatisfactory results may be regarded as exceptional, and this view is said to be confirmed by the trading results during the past few months.

Swiss and Russian Companies.

The shareholders of Brown, Boveri & Co., of Baden, which has a share capital of £500,000, and a loan debt of £60,000, have just approved the accounts for the year 1901—1902. Apparently influenced by the reaction in the Continental industry in general, the undertaking shows a considerable decline as compared with the preceding year. The accounts reveal gross profits amounting to £118,328, as against £166,031 in 1900—1901. It should be noted that the greater portion of the former sum arises from manufacturing operations, only about £7,000 accruing from investments and participations, which have only yielded an average of 2·4 per cent. Among these enterprises may be mentioned the Brown-Boveri Co., of Mannheim, whose dividend has fallen from 10 per cent. to 4 per cent., whilst the Motor Co., of Baden, which distributed 6 per cent. for 1900, has been unable to pay any dividend for the year. The net profits reach £29,046, as compared with £90,840 in the previous year, and the dividend amounts to 5 per cent., as against 16 per

cent. This remarkable diminution is explained by the fact that prices have receded to such a level that contracts in the electrical industry must almost be carried out a loss, and the essential cause of the company being able to realise a profit at all lay in the possession of orders of long standing, which were completed during the year under consideration. Apart from various large installations executed or still in hand, the company has been very successful in the new branch of steam turbine construction from the contract point of view, although positive financial results have not yet been attained. So far, however, 17 steam turbines and dynamos of a total of 20,120 H.P. have been delivered, one being of 5,000 H.P. for the Frankfort station, and a second of 8,000 H.P. for Milan. The report of the directors states that it is at present impossible to form any opinion as to the future of the electrical industry, but that from the purely manufacturing standpoint the current year must be less favourable than the past 12 months.

The Swiss Co. for Electrical Industry, of Basle, which is intimately associated with the Siemens & Halske Co., of Berlin, is an investment undertaking for Switzerland, although most of its participations are in neighbouring countries. It has a nominal share capital of £800,000, of which about one-half has now been called up, and a large issue of bonds, necessitating the payment of £48,000 per annum as interest. As might be expected, there was little inducement during 1901 for the company to engage in new enterprises, in consequence of the general situation of affairs, whilst, at the same time, the conditions were unfavourable for a realisation of portfolio securities. As a result, the operations of the company were restricted to the development of the undertakings in which it is interested, but even this policy has not, apparently, improved the position. The company's report indicates a gross profit of £55,228, as compared with £59,741, and after deducting the interest on bonds and expenditure, there remains a net profit of £4,013, as against £7,203. It has, therefore, been impossible to pay any dividend on the ordinary shares, although 4 per cent. was distributed on a less amount of capital for 1900. In addition to being interested in Russian, Italian, German and French undertakings, the company is a shareholder in the Mexican Electric Works, Ltd., of London.

The report of the Motor Company for Applied Electricity, of Baden, which stands in close relation to the Brown-Boveri Co., states that with the exception of electrical undertakings situated in large towns, those in other places yielded scarcely any gratifying results for 1901. The consequence has been the manifestation of reserve in the promotion of new enterprises, and the company's operations have been mainly limited to the working of the undertakings in which it is interested. Apart from the share capital of £340,000, the bond issue has been increased from £240,000 to £320,000, and after meeting the interest payments on the bonds and providing for expenses and depreciation, the net profit amounts to £2,695, as against £14,730 in 1900. The balance does not allow of the payment of a dividend, whereas a distribution at the rate of 6 per cent. was made for the preceding 12 months. The greater portion of the company's capital is invested in its own installations.

The experience of foreign electrical companies in Russia has been similar in a large measure to that of iron and steel enterprises inaugurated with the financial assistance of other countries. The St. Petersburg Co. for Electrical Enterprises, which was formed over two years ago by the Helios Co., of Cologne, and its financial group with a capital of 6,000,000 roubles, which declared a dividend of 2 per cent. for the first year, has been compelled to pass any distribution for 1901-1902. According to the company's accounts, the gross receipts advanced from 669,858 roubles in 1900-1901 to 702,418 roubles last year, but the expenditure increased from 355,142 roubles to 667,511 roubles, thus leaving a net profit of only 34,907 roubles. It has been proposed to make an issue of obligations, but circumstances have not proved favourable to the projected bonds being offered for subscription down to the present time.

The General Electricity Co., of St. Petersburg, which was promoted by the Allgemeine Elektricitäts Gesellschaft, of Berlin, in 1898, with a capital of 1,000,000 roubles, has closed the year 1901 with a net profit of 27,954 roubles, as against 144,831 roubles. There has, therefore, not been any distribution on the share capital for the year, whereas 10 per cent. was paid for the previous 12 months. The Westinghouse Co., of St. Petersburg, which during the past year increased its share capital from 2,000,000 roubles to 3,000,000 roubles, has been able to declare a dividend of 20 per cent. on the original capital, and 10 per cent. on the new capital for 1901. This is the first distribution since the formation of the company in 1898. With regard to the position of supply companies, the St. Petersburg Co. for electric lighting from 1886 has been able to increase its dividend of 1 per cent. to 1½ per cent. for 1901, whilst the Moscow Central Electricity Co. (a Belgian concern) has been unable to make any distribution for the past two years.

BUSINESS NOTES.

Packages for Abroad.—Messrs. Neale & Wilkinson, of 32, St. Mary Axe, E.C., have issued a revised A.B.C. tariff of rates and information useful to those who have occasion to send packages abroad. The cost of conveyance to almost any part of the world is shown, and in the cases of South Africa, India, Australia and other places, the rates are cheaper than parcel post without any limits as to size and weight.

Electrical Wares Exported.

Week ending Oct. 15th, 1901.		Week ending Oct. 14th, 1902.	
Amsterdam	Value £90	Auckland. Elec. tram cars	Value £6,780
Auckland	80	,, Teleg. apparatus ..	230
,, Teleph. mat. ..	195	Bangkok	640
Bombay	141	Bombay	640
,, Telephones	214	Brisbane. Teleg. apparatus ..	250
Buenos Ayres	88	Buenos Ayres. Teleg. cable ..	541
,, Teleph. cable ..	945	Calcutta	1,472
Calcutta	1,189	Callao. Submarine teleg. cable	9,900
Cape Town	89	Cape Town	7,334
Christiania. Teleg. wire ..	33	,, Teleg. mat. ..	2,562
Durban	3,612	Colombo	31
,, Elec. tramway mach'y	4,153	Copenhagen. Elec. cable ..	2,446
East London	80	Durban	513
,, Teleg. sundries ..	72	,, Teleg. mat.	2,100
Gothenburg. Teleg. cable ..	1,531	East London	373
Grenada. Teleph. mat. ..	60	,, Teleg. goods ..	686
Hamburg	24	Fremantle	35
Hong Kong	1,208	Gothenburg	105
Kobe. Teleg. cable	6,534	Hong Kong	25
Madras	1,988	Karachi	127
Melbourne	110	Kobe. Teleg. cable	1,464
Port Chalmers. Teleph. mat.	71	Madras	40
Rosario	85	Melbourne	173
Rotterdam. Teleg wire ..	48	,, Teleg. wire	905
Shanghai	163	Mossel Bay	34
,, Submarine teleg. cable	7,319	Ostend	43
Sierra Leone. Teleg. cable ..	20,040	Perth	51
Singapore	80	Rosario. Teleph. mat. ..	967
,, Submarine teleg. cable	48,000	St. Petersburg	70
Stockholm. Teleg. cable ..	476	,, Teleg. wire ..	113
Sydney	1,033	Sekondi. Teleg. mat.	904
Wellington	626	Sierra Leone. Teleg. mat. ..	113
,, Teleg. mat.	628	Singapore	55
		Stettin	77
		Sydney	400
		,, Teleg. mat.	45
		Tokio. Teleph. cable	1,800
		Vera Cruz	9,900
		Yokohama	91
Total ..	£100,925	Total ..	£54,624

Foreign Goods Transhipped.

Colombo. Elec. light mat.	Value £13
Genoa. Elec. goods	10
Rangoon. Elec. mat.	22
Total ..	£45

Consular Notes.—*Russia.*—The town of Nicolaieff is now lit by electricity from a central power station built for the municipality under special contract. This, remarks Vice-Consul Woodhouse, is a welcome change after the semi-obscurity of the petroleum lamps. There is talk, he states, of the Belgian Tramway Co. substituting electric for horse traction. Nothing was settled, however, at the time of writing, as the municipality and the company were still discussing terms.

France.—In a report on the chemical and metal industries of the consular district of Lyons, Consul Liddell states that in Lyons the electric motor has in many factories replaced steam, gas and petroleum engines, and, consequently, caused a diminution in the manufacture of the latter, but the manufacture of dynamos and other machinery for the transmission of electric power has greatly increased. There has been, he remarks, some break in the establishment of electric factories in the Alpine districts, but it is believed that there is a future in store for these factories. Motor-power at a cheap rate would create in Lyons and neighbourhood flourishing industries. The development of telegraphs and telephones, and the proposed extension of cables to French colonies is of interest to Lyons, as being one of the chief centres of manufacture. In regard to chemical industries, he expresses the opinion that if electrolysis were to become general it would cause a revolution in many of the industries, and Lyons, on account of its reserve of hydraulic force from the Alps, should become the centre of the new industry. Reporting on the mining industry of the basin of the Loire, Mr. Liddell refers to the electric improvements which has been inaugurated. Electric plants have been introduced into many pits. For example, the Péronnière Co. experimented successfully with a system of electric boring for soft strata; the Firminy Co. erected a 40-H.P. electric station to supply the pump at the Monterrad Pit with a current of 1,000 volts; the Montrambert Co. commenced building a central electric station to supply the pits with electric light and motor power; the company of the Mines de la Loire introduced, in the gallery running from the Loire Mine to the Rambaud Pit, traction by electric locomotives on the trolley system; the Péronnière Mining Co. further began building a large electric station, furnished with three dynamos of 300 H.P. each, giving a current of 3,000 volts to the electric pump at the Piney Pit, to the ventilator at the St. Marcellin Mine, and the screening yard at the Couchoud Pit; and for blasting charges electricity is more and more used.

Assessment of Electrical Works.—In conjunction with other large firms affected, Messrs. Crompton & Co., Ltd., electrical engineers, of the Arc Works, Chelmsford, have protested against the action of the Union Assessment Committee in making an alarming increase in the rateable value of their premises. The increase of Messrs. Crompton & Co.'s works is from £825 to £2,890. In a representation to the Assessment Committee, the firms point out that the increases are a serious injustice to the enterprise of local manufacturers, and will tend to cripple the industries of the town.

Motor Starters.—Messrs. Monte Callow & Co., of Broadway, Ludgate Hill, who are handling the Perfecta motor starter, inform us that they have secured the contract for the starters at Messrs. Cammell's Works.

Trade Announcements.—Messrs. F. W. Smith & Co., Ltd., electrical and mechanical engineers, have recently removed their Manchester offices to larger premises at Nos. 181 and 183, Chapel Street, Salford.

The offices of the *British and South African Export Gazette* have been removed from 117 and 118, Leadenhall Street, to 33 and 35, Eastcheap, E.C.

Mr. John Whitelaw has started business at 15A, Duncan Street, Edinburgh, as an electrical engineer, and will make a speciality of electrical repairs, particularly those relating to generators, motors, arc lamps, switches and resistances.

Mr. H. Bailey informs us that he is about to start in business at 52 and 54, Blackburn Road, Accrington, as electrical engineer and contractor, and would be glad to receive catalogues from the trade. Mr. Bailey has been for four years with Mr. Giles, borough electrical engineer, Blackburn.

In view of the prospective increase of heavy traction work in the future, the British Thomson-Houston Co., Ltd., of Rugby, has organised a "heavy traction" department. Mr. A. H. Walton, in addition to his other duties, has been appointed manager of this department, with headquarters in London; his large experience and success in installing some of the heavy electric traction schemes in the United Kingdom well fit him for this position.

Mr. Arthur Jacob has been appointed general manager of the British Schuckert Electric Co., Ltd., and his address will in future be Clun House, Surrey Street, Strand, London, W.C.

Messrs. Moesch & Schmidt are now representing the interests in the United Kingdom of the Société Hollando-Belge l'Industrie Electrique, who manufacture all types of electrical machinery, and whose speciality is the well-known Thury system for transmission of power by high pressure continuous current.

Catalogues.—Messrs. Mackies, Ltd., of Caversham Road, Reading, are issuing lists of their pulleys and friction clutches.

Messrs. Drake & Gorham, Ltd., who are the sole agents for the Jandus Arc Lamp and Electric Co., Ltd., have just brought out an October, 1902, catalogue describing the principal features of the Jandus lamps which are very extensively used for public and interior lighting in all parts of the country. Prices are given of complete lamps and also of parts therefor. There are lists given of many authorities who are daily using the Jandus lamps, and many excellent testimonials. The list is handy in form, and is well illustrated and set out. The trade can obtain copies on application.

We have received from the Howard Conduit Co., Ltd., of Trafford Park, a specimen card that they are issuing concerning the use of their asphalte solid system, more especially for services. It gives the most suitable stock, sizes and prices, also an idea of the quantities of bitumen and asphaltic concrete required; as it gives these details at a glance it is calculated to save engineers and mains superintendents the trouble of wading through catalogues.

Messrs. R. W. Blackwell & Co., Ltd., have forwarded to us a copy of "Switchboard Practice," which is a publication issued by the Cutter Co., of Philadelphia, the manufacturers of the well-known I.T.E. circuit-breakers, for whom they act as sole European selling agents. They have also sent us a number of loose sheets illustrating special types of instruments which have been constructed at different periods. Among other noticeable things in the catalogue is fig. No. 29, which shows a special booster circuit-breaker, four of which are at present in operation in a big electric power station, they being instruments specially designed for the work. It will also be of special interest to our readers to know that on page 80 there appears an illustration of a circuit breaker built up to 10,000 amperes capacity.

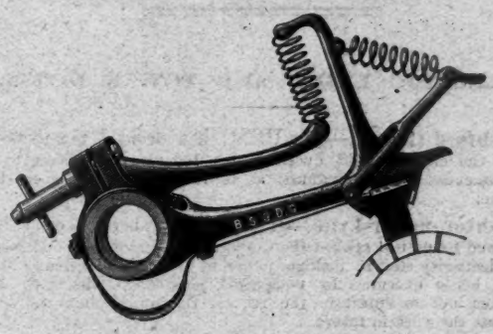
A new booklet has been issued by the Schattner Electricity Meter Co., on "the cost of production and sale price of electrical energy." It discusses the maximum demand indicator, and gives an illustrated account of the Atkinson-Schattner instrument.

A new price list of india-rubber goods for mechanical, engineering and scientific purposes has been issued by the North British Rubber Co., Ltd., of Edinburgh.

The G.E.C. Fire.—In the City of London Court on Monday, six claims for compensation were adjudicated upon against the General Electric Co. (1900), Ltd., 71, Queen Victoria Street, at the instance of girls who were injured in the Queen Victoria Street fire. Mr. Morley, who appeared for all the claimants, explained, says the *Times*, that the actions were brought under the Workmen's Compensation Act. The girls were on the fourth floor of the building when the fire occurred, and they had to jump to the ground to save their lives. They suffered from shock and other injuries, and the company had now agreed to compensate the girls by paying £150 to each of them. They were 14 to 16 years of age, and they had gone back to work; but they were entitled to damages under the Act. In each case the parents had already received £10 from a fund which was raised; and it was now asked that the Court might award a sum out of the £150 for each girl's benefit. Judge Rentoul said that each girl's parent would have £10 to defray the expense which had been occasioned to him, and the balance of £140 would be invested by the Court until the girls were 21 years of age, the interest in the meantime to be paid for the benefit of the girls themselves.

Electric Power in Shipyards.—Messrs. Harland and Wolff, Belfast, are at present putting down considerable plant for lighting and power purposes. Messrs. The Fairfield Shipbuilding and Engineering Co., Govan, are also putting down extensive power plant, and they are adding an electrical department to their shipyard, so as to undertake the completion of all ships by their own staff.

The "Supra" Brush-Holder.—This new brush-holder, which we illustrate below, is made by Mons. L. Boudreaux, of Paris, and is sold in this country by Messrs. D. Santoni & Co., Ltd., of 22, Goswell Road, E.C. It is made up of two independent steel parts, one inserted in the other; one is tightly fixed by means of a split ring on the rod supporting the brush-holder, the other, by means of rings, freely oscillates round this rod. The former carries at its opposite extremity a tension spring which is connected with the latter; this spring presses the brushes radially upon the commutator. The second part, constituting the brush-holder proper,



is composed of two pieces, which together form a gripper between the jaws of which the carbon brush is tightly held by means of a second spring, as shown in the illustration. The powerful grip exercised by means of the great leverage obtained ensures intimate contact between the brush and the flexible copper conductor, which conveys the current to the brush-holder carrier. The use of steel enables the parts to be made light and strong, so that the brush easily follows irregularities of the commutator surface, and the spring pressure is exercised in the most effective manner.

For Sale.—Messrs. P. Huddleston & Co., of 72, Finsbury Pavement, E.C., will sell by auction on Thursday, October 23rd, at Raikes Hall, Blackpool, electrical plant including dynamo, accumulators, arc lamps, &c.; and at the Pier, Southend-on-Sea, on October 30th, the electric generating plant used for running the Pier tramways and lighting the Pier. For further particulars see our advertisement pages this week.

Dissolution.—Messrs. A. F. Lord and A. E. Torrie (Lord & Shand, electrical engineers, Plymouth) have dissolved partnership.

Books Received.—"Fire Tests with Doors Composed of Deal and Uralite," No. 67. London: The British Fire Prevention Committee, 1902. 2s. 6d. net.

"The *Mechanical World* Pocket Diary and Year Book for 1903." Manchester: Emmott & Co., Ltd. 6d. net.

Brighton Exhibition.—In our brief notice of this Exhibition last week, we omitted to mention that Mr. G. Braulik is lighting up the large stall of Messrs. J. H. Holmes & Co. with his 16-hour arc lamps and also "Flame" lamps.

The plant exhibited by Messrs. D. Bruce Peebles & Co. includes three polyphase induction motors of their completely protected type, the outputs varying from 37 H.P. to 1 H.P.; also six standard multipolar protected-type motors varying from 30 to ½ H.P. The particular feature in all of the above machines is their sound mechanical construction, particular attention being paid to lubrication and bearings, to allow of the motors running continuously on load without heating. The electrical construction is also carefully designed. In the case of the continuous-current motors, these will run absolutely sparklessly at all loads up to 25 per cent. overload. In the case of the induction motors, particular care is taken in the design to obviate heating due to eddy currents, careful lamination of the stator and rotor cores being a special feature. The rest of the plant exhibited consists of one of the firm's standard protected-type motors of 5 B.H.P. directly coupled to one of Messrs. Gwynne's twin series pumps; also one of their standard battery-boosters, consisting of two P.P.P. open-type machines directly coupled together on a combination bedplate, and running at a speed of 1,000 revolutions per minute, the motor being wound for 100 volts, and the generator having an output of 200 amperes at 12 volts.

Exhibition Notice.—We have received a prospectus regarding the International Engineering, Machinery, Hardware and Allied Trades Exhibition, which will be held at the Crystal Palace in the Spring of next year. In the list of patrons of this Exhibition we notice the name of Lord Kelvin and many other important personages connected with the Engineering and Allied Trades. The Exhibition will open on March 2nd and close on May 31st. Plans and full particulars can be obtained from the Organising Commissioner of the Exhibition, Crystal Palace, Sydenham.

Electric Mail Vans.—We are informed that the success attending the recent trials, made by the Postal Authorities in the E.C. district with the "Oppermann" patent electrical mail van, has induced them to further test the suitability of this type of motor van on another and more difficult route. The one chosen for the present trials, which commenced on Tuesday, was in the Battersea district.

Deed of Assignment.—All claims against the estate of Joseph Hamer, electrical engineer, of 3 and 4, Horton Street, Halifax, who has executed a deed of assignment, must be sent to the trustee, Mr. Jonathan Ingham Learoyd, of the Lancashire and Yorkshire Bank Chambers, Halifax, by October 25th.

Honduras.—The U.S. Consul at Puerto Cortez reports, under date of September 1st last, that manufacturers of electric supplies and of material for waterworks may find an opening to sell their goods to the industrial company recently organised at Ceiba.

ELECTRIC LIGHT AND POWER NOTES.

Ashford (Kent).—The U.D.C. has decided not to postpone the electric light question, but to interview certain firms recommended by Mr. Medhurst as to terms for carrying out the scheme.

Ashton-under-Lyne.—The local Plumbers' Society has renewed its protest against the Corporation employing members of the electricity staff in making joints in the cables, instead of the work being executed by recognised plumbers. The T.C. has decided not to entertain the request that only plumbers shall execute the work in future.

Brighton.—The Electric Lighting Committee has recommended the T.C. to insert in its Bill a clause authorising the Corporation to supply current for lighting to the following places outside the borough:—Rottingdean, Ovingdean, Patcham, Falmer, Haugleton, Old Shoreham, New Shoreham, Kingston-by-Sea, Southwick, Aldrington, Lancing, and West Blatchington.

On the advice of the electrical engineer (Mr. J. Christie), the T.C. has been recommended to improve the lighting of the Aquarium entrance by a scheme outlining the structure, and the points of the building, with electric lamps. From 400 to 450 lamps will be required at an outlay of £375, and the light will cost 2d. per unit, or 2s. 6d. per hour.

Brixham.—The U.D.C. has decided to enter into an agreement with Messrs. Crompton & Co. whereby the Council shall obtain a prov. order, and Crompton & Co. will carry out and work the electric light undertaking, refund the cost of the order and rent the same. The Council is to have the option of purchase at stated periods, on stated terms. The company undertake to wire houses free, to carry out the work within two years, and to supply energy for private lighting at not more than 7d. per B. of T. unit for the first hour, and 3d. afterwards. For cooking and heating purposes the price is not to exceed 3d. per unit, for public lighting 3d., and for public offices 4½d.

Camborne.—The U.D.C. has asked the local electric lighting company to quote terms for lighting the town by electricity.

Cleckheaton.—The L.G.B. has sanctioned a further loan of £6,000 for electricity purposes.

Coalville.—Messrs. Baker, Lees & Co. have intimated to the U.D.C. their intention to apply for a prov. order to supply the district.

Crewe.—Electricity is being utilised for driving the machinery at the large clothing works at Crewe, in place of steam.

Devonport.—The Admiralty has informed the T.C. that a comprehensive scheme is being prepared for supplying electric light and power from a station in the Dockyard.

Dorking.—On the advice of Mr. Trentham, the U.D.C. has decided to apply to the L.G.B. for a loan of £20,000 for the purpose of establishing electricity works. The Parliamentary agents to the Leatherhead Electricity Co., Ltd., have written to the L.G.B., stating that they intend to apply to the B. of T. to cancel the E.L. order of 1897, and suggesting that, having regard to the financial aspect of the question, the L.G.B. should not entertain the application for the loan. The Council has decided to inform the L.G.B. that any such application to the B. of T. will be strongly opposed, as under a contract with Edmundson's Corporation it is incurring practically no risk.

Dundalk.—The electric tram and lighting scheme has been revived. The Council last week had a letter from the Dublin syndicate (Messrs. Ryan, Porte and Liller) asking the Council to apply for an extension of its powers (which expire in November), and offering to lodge £400 to meet the expenses of obtaining the lighting order on condition that the Council transfers it to them. The Council decided to accept this offer.

Fareham.—The U.D.C. has decided that in future a fixed sum of £655 per annum shall be charged for lighting the streets with electricity.

Faversham.—The Kent Electric Power Distribution Co. has submitted to the T.C., which has applied for a loan for electric lighting purposes, an offer to supply the Council with electricity within a year. The Council has referred the matter to its engineers.

Finchley.—The local company is pushing on with its work and is booking up orders rapidly. Notwithstanding the recent decisions in the High Courts, the overhead conductors are carried across two public highways, Regent's Park and Cyprus Roads, and the company is seeking to obtain consent from Hendon U.D.C. to allow it to carry conductors across two bridges over the Brent. It is unlikely the Council will give the consent asked for.

Glasgow.—Late on Wednesday evening last week a total interruption of the electricity supply took place in Bothwell Street. The current was cut off at 10.30 p.m., and was not restored till about two hours later. The district is supplied from the old Waterloo Street station at 200 volts.

Handsworth.—The B. of T. has called the attention of the U.D.C. to the fact that nothing appears to have been done with regard to the electric lighting order obtained in 1899. It was decided to reply that the Council had purchased the site for the works, and it hoped before long to have plans and specifications prepared for a generating station.

Hendon.—The B. of T. has written to the U.D.C. stating that it will postpone the consideration of the revocation of the prov. order until the end of the year. The U.D.C. has received tenders for the sale of the order from the National Electric Wiring Co. and from Messrs. Crompton & Co., Ltd. No decision has been come to, and it is understood that an electrical expert will be called in to advise in the matter.

Horsham.—The U.D.C. on October 8th decided to apply to the L.G.B. for a loan of £9,500 for electric lighting purposes.

Hucknall Torkard.—The E.L. Committee of the U.D.C. has had under consideration the question of supplying the electric light in the district, and has interviewed Messrs. Ford and Barker, representing the Notts. and Derbyshire Electric Power Co. The company is erecting a power station at Ilkeston, and hopes to be able to supply Hucknall about the middle of next year.

Ingleton.—The P.C. has accepted the tender of the local electric light and power company at £55 16s. 7d. for lighting the streets with electricity for the winter.

Italy.—An interesting electrical installation is at present in course of realisation, which will permit, when completed, a new and important distribution of electric energy at Turin. At the foot of Mont Cenis a central power station is being erected for the utilisation of a waterfall of 9,000 H.P., capable of being augmented to 12,000 by utilising in addition the adjacent lake of Mont Cenis In this station three electric units, comprising each a turbine of 1,600 H.P., driving a dynamo of 1,200 KW., will generate three-phase current at 3,000 volts. Later on the power of the station can be doubled. In order to transmit the current economically to Turin, a distance of about 60 kilometres, the pressure will be raised to 30,000 volts. At Turin it will again be reduced to 3,000 volts, and will be distributed at this pressure for motive power and lighting purposes.

Kingston-on-Thames.—In view of the extensions at present being made at the works, the T.C. has postponed the appointment of an expert to advise on the electricity undertaking for six months.

Littleborough.—The Electric Lighting Committee has recommended the U.D.C. to apply for a loan to cover the cost of increasing the electric lighting plant.

Liverpool.—A movement is in progress at Liverpool for providing a supply of electrical energy at the docks for the use of ships while loading and unloading. The electric light is at present in use at the Canada graving dock and at the Waterloo Dock, but the movement in question aims at securing a supply of electricity over the extensive system of docks owned by the Mersey Docks and Harbour Board. A supply available for ships' use would confer a two-fold advantage. It would improve the lighting for the docking, berthing and undocking of vessels by night, and it would greatly improve the conditions of working cargo when ships were in berth. Most of this cargo work is still done by the light of gas or oil lamps, though the larger steamers have their electric hatchway and deck lights. What is most wanted is a supply of electric light "below," down in the holds of vessels where the actual work of stowing or releasing cargo is done. By means of an available supply of electricity at the dock-side, and lengths of light, insulated cables, a supply could be carried down into the holds, on vessels taking up their berths. The subject is one of great interest to shipowners, and to the men who are engaged in loading and unloading vessels in the docks.

Llangifni.—Mr. Pryce White, the managing engineer of the Bangor electric light works, has been asked to advise the Llangifni U.D.C. as to the installation of the electric light in its district.

Lye and Wollescote.—The B. of T. has written to the U.D.C. pointing out that the order for electric lighting granted in 1899 is coming to an end, and asking for observations before it is cancelled. The matter has been referred to the Midland Electric Co. and the clerk.

St. Annes.—The U.D.C. has decided to light Orchard Road, St. Patrick's Road South, and Cambridge Road, by electricity in preference to incandescent gas.

(Continued on page 667.)

NOTES ON THE PRACTICAL WORKING OF ROTARY CONVERTERS.

By J. R. SALTER, Engineer-in-Chief, South Lancashire Tramways Company.

The main object of this article is to demonstrate the flexibility of the rotary converter when employed in a combined alternating and continuous current station. It is, of course, well known that a rotary converter is reversible in its action and can be employed for converting either from alternating to direct current or from direct current to alternating; but there appears to have been some doubt as to its successful operation when converting from direct to alternating current, and there has consequently been some reluctance in adopting such an arrangement for practical working.

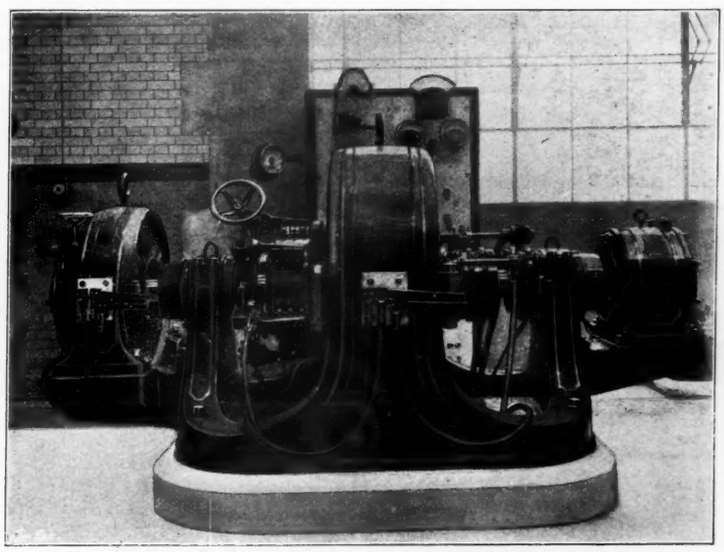


Fig. 1.

The writer, however, adopted such an arrangement in a large station with which he was connected, and it has proved so successful that it has been determined to increase this use of the rotary converter. The plant in the station referred to consists of two direct-current 500-KW. compound-wound generators, and one three-phase 5,000-volt 25-cycle alternator, together with the rotary converter. The rotary converter has been used for running as a direct-current generator in parallel with one of the direct-current sets, being driven by the three-phase alternator, or for generating alternating current in the event of the alternator being shut down, and, further, for running in parallel with the alternator in times of excessive load on the sub-station. If this arrangement had not been adopted, it would on occasions have been necessary to run the whole of the plant in the station during times when one portion of the plant was overloaded on account of extra traffic, thus leaving no spare plant in the station. There was the further advantage of the economy in running two sets fully loaded instead of three sets partially loaded.

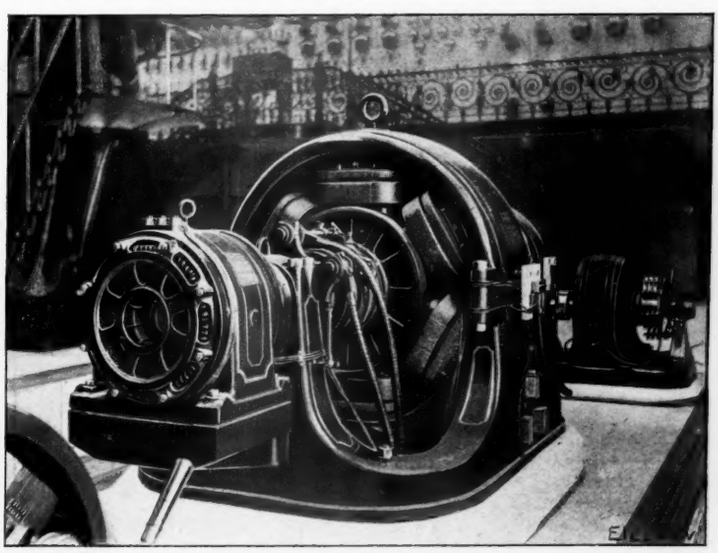


Fig. 2.

It may perhaps be well before discussing the operation of the rotary converter as an alternating current generator to describe the machine. Figs. 1 and 2 give a general view of the rotary converter, which was supplied by the British Westinghouse Electric and Manufacturing Co. The machine has a capacity of 250 KW., the voltage on the alternating side being 330 volts, whilst on the direct-current side it is compounded for 500 to 550 volts. At one end of the shaft there is directly coupled an induction motor for starting, although when the machine is running as a direct current motor it is quite easy to start up on the direct current side without using this motor. At the other end of the rotary converter there is a booster mounted directly upon the shaft, this booster being in circuit with one of the rail feeders. The induction motor has its rotor, which is the secondary, pressed upon the extended shaft of the rotary converter, and tappings are taken from the low tension side of the transformers through a triple-pole switch, which controls the starting of the motor, to the stator. This motor, being of the induction type, can start and bring the rotary up to speed with a relatively small current. It is provided with a slightly smaller number of poles than the rotary converter, and the speed, therefore, becomes higher than the synchronous speed of the rotary. In one phase, therefore, of the rotary is inserted an adjustable resistance which causes the rotary to act as a generator, loading the motor until the rotary is brought into synchronism with the alternator. In bringing the speed of the rotary up to syn-

chronous speed some advantage is also derived from varying the excitation of the rotary, and consequently the iron losses

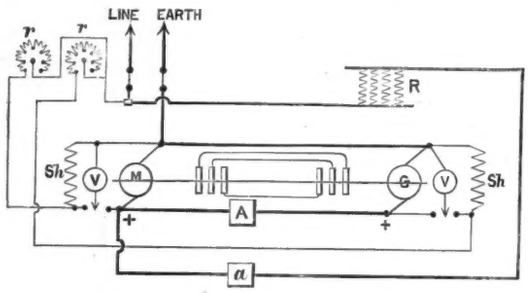


Fig. 5.—Connections for Efficiency Test.

in the armature and field. The losses in the rotary vary approximately as the square of the voltage, and the speed of the motor falls in proportion as the torque is increased.

This method of starting up the rotary converter is employed when running the machine in the ordinary way as a direct current generator, and the machine can then be paralleled with the direct current sets in the same way as paralleling ordinary compound-wound generators. The machine runs perfectly satisfactorily in this way, though it may be remarked that the greater part of the variation in the load is taken up by the rotary converter. This is due to the fact that the series windings produce a leading current, increasing the impressed pressure, and, therefore, the direct current pressure.

If no continuous current is available for starting up the rotary, it may be run up on the alternating current side by opening the field circuit, but inasmuch as the starting torque is then produced by the hysteresis drag and by eddy currents, it would appear that the machine must be inefficient at full load in order that the losses shall be great enough to obtain the necessary torque. The method then of starting up adopted here, although necessitating the provision of a small induction motor, has a considerable advantage over the last-mentioned method.

When the rotary converter is supplied with direct current and delivers alternating current, the speed is no longer held constant, as in the case when the rotary receives current from an alternating circuit in which the frequency is fixed by the speed of the alternator. Of course, when the rotary is driven by direct current, the speed follows the law of an ordinary direct current motor, and is equal to $\frac{E}{I} \frac{60 \times 10^8}{x\,m}$ where I is the induction, E the applied electromotive force, m the number of armature conductors, and x the number of poles; that is to say, it is governed by E and I, and is affected by armature reaction. The armature reaction due to lagging currents on the alternating side has a demagnetising effect upon the field which may become very considerable. As the field weakens, the lagging currents increase, and the effect becomes cumulative. The rotary, therefore, is liable to wide changes in speed with changing loads, which become excessive when an inductive load is thrown on, unless some means are taken to prevent it.

The method employed for overcoming the instability in the speed of the rotary when driven as a direct current motor, is to excite the rotary by means of a small generator, which is driven from the rotary itself. Tappings are taken from the three-phase side of the rotary to a small induction motor, which is directly connected to a small continuous current generator. This generator works low down on the characteristic curve, and is unsaturated at the normal electromotive force. Any change in the speed of the rotary, therefore, causes a much greater change in the electromotive force of the exciter, and this varies the field of the rotary, and keeps the alternations constant independent of the nature or amount of the load. The small exciter set is shown in fig. 3. The exciter generator has a normal voltage of 220 volts with a current of 6 amperes. Arrangements had to be made for putting the rotary field coils in two parallel sets when excited in this manner.

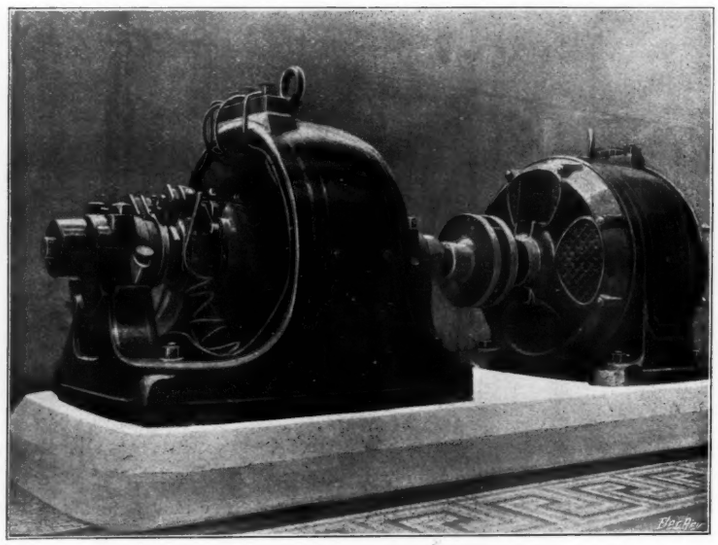


Fig. 3.

The rotary was frequently run under these conditions, and with very satisfactory results. On the alternating side it was connected to the low tension side of the transformers in the generating station, the high tension side of the transformers being connected to the sub-station feeders. At the sub-station the current was transformed down, and, by means of a second rotary converter at the sub-station, the lines in the vicinity were supplied with direct current. The system was capable of working 20 cars without hunting, and also of

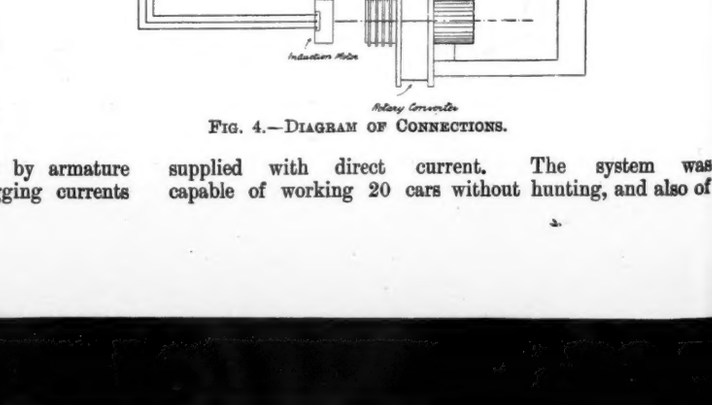
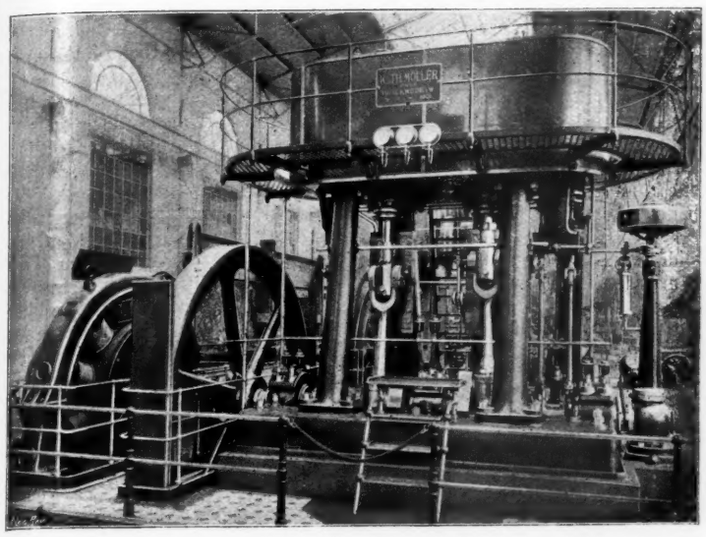


Fig. 4.—Diagram of Connections.

working in parallel with a second rotary converter sub-station operated by the main three-phase generator. For starting the rotary up as a direct current motor the series coils were cut out and the machine run as a shunt-wound motor. It was found that when operated as a shunt motor and working in parallel with the alternator supplying the same feeders the rotary frequently fell out of step. On reversing the series coils, however, the rotary kept perfectly in step with the main generator. Fig. 4 gives a diagram of connections showing the arrangement of this plant.



Düsseldorf Exhibition: Möller Vertical Engine and Lahmeyer Dynamo.

It will be observed what an important part the series coils play in maintaining the stability of the system and preventing hunting. The method of regulation frequently employed in connection with rotary converter equipments is to insert self-induction between the slip rings and the transformers, and by this means the impressed pressure, and consequently the direct current pressure, is varied. In the equipment referred to, however, no such arrangement was adopted, the transformers being designed with large magnetic leakage, and the rotary being so designed that the series coils affected the excitation to the extent necessary to vary the impressed pressure so as to maintain stability. As explained above, the series excitation was a little too great for perfect parallel running with the direct current generators. When generating alternating currents, however, and although being separately excited as a shunt-wound motor by means of an arrangement designed to increase the excitation in proportion as the speed increased, on account of lagging currents, the rotary did not maintain absolute synchronism unless the series coils were utilised.

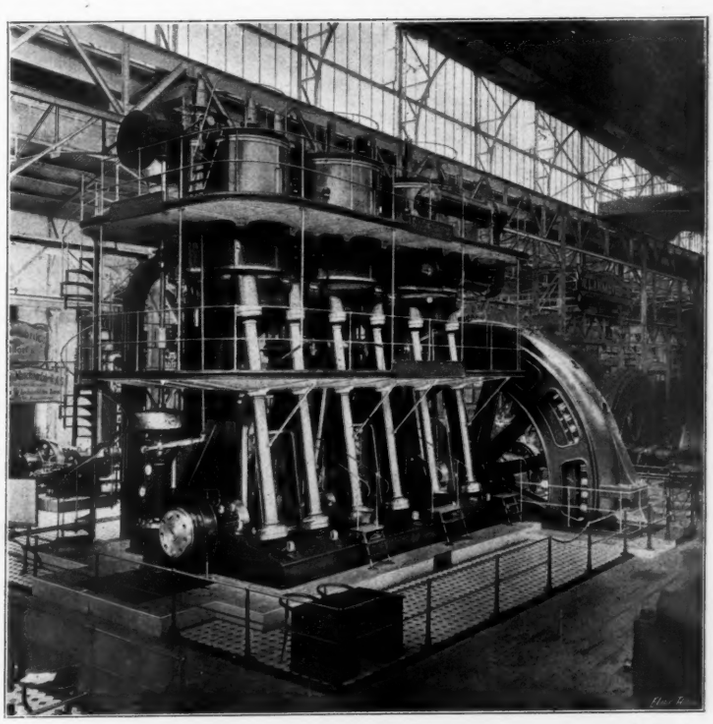
It may be of interest to point out how easily two such rotaries may be tested differentially, in the manner first devised by Dr. John Hopkinson for continuous current generators. Fig. 5 gives a diagram of connections for such a test. The D.C. and A.C. sides of the rotaries are directly connected to each other, one machine running as a three-phase motor, generating continuous currents, and driving the other rotary as a continuous-current motor, generating three-phase currents, which in turn drive the first machine, the losses being supplied from the line. I believe this was the first attempt to apply the test to rotary converters, and I regret that as the machines were required for operating the system the results are not available. It should, however, be pointed out that this test cannot be strictly accurate, as owing to the alteration in the field excitation necessary to adjust the machines one to run as motor and the other as generator, the fields, and consequently the power factors, of the rotaries must be so altered or varied as to seriously affect their efficiencies.

Incidentally it may be remarked that in the equipment referred to a considerable amount of lighting was done off the low-tension side of the transformers. The whole of the sub-stations, car sheds, and depôts were thus lighted, the lamps being connected "delta" fashion, six in series across each phase. The sub-stations were too far away to be lighted by the direct-current machinery in the generating station, and one direct-current machine sufficed to light the generating station and to drive the rotary supplying the sub-station feeders through the transformers in the generating station. By this means the capital cost of batteries was avoided and the advantage of high-tension transmission maintained with only one steam set running, and that at full load. The lighting was extremely satisfactory, not the slightest pulsation being discernible.

ELECTRICAL PLANT AT THE DÜSSELDORF EXHIBITION.

(*Continued from page* 568.)

The exhibit of Messrs. K. & Th. Möller consists of a vertical compound steam engine, direct coupled to a Lahmeyer dynamo of 275 kw. at 440 to 500 volts, 120 revs. per minute. This set is standardised with its own condensing plant, of the jet type. The high pressure cylinder is 540 mm. in diameter, the low pressure 860 mm., and the stroke 550 mm.; the output, with a steam pressure of 120 lbs. per sq. in., and at the normal speed of 140 revs. per minute, is 420 to 550 h.p. The design of the engine is



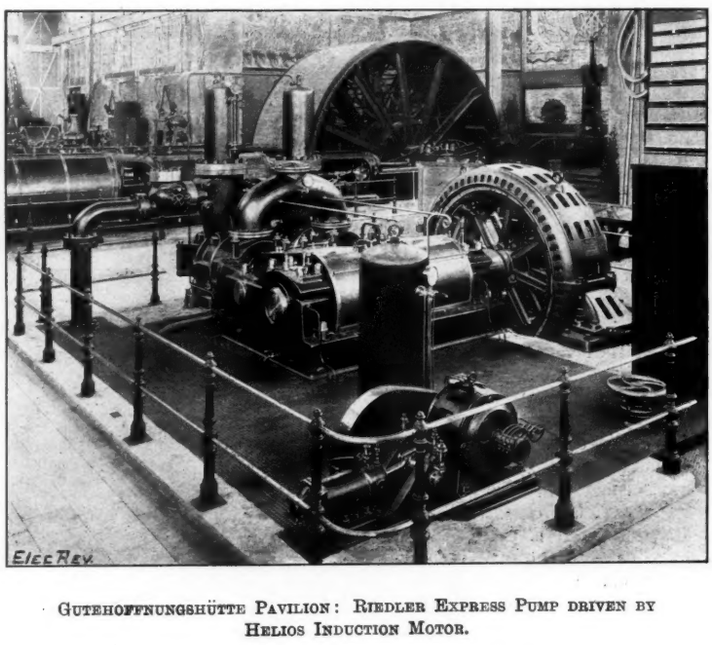
Düsseldorf Exhibition: Gutehoffnungshütte 3,000 h.p. Engine.

specially intended for working with highly superheated steam, which has come so much to the fore of late. The high pressure cylinder is provided with Rider expansion valve gear of the piston type, the main valve being fitted with spring packing rings, while the expansion valve is accurately ground in place. The parts of the valve are specially designed with uniform thickness of walls as far as possible, internal ribs being avoided, so as to prevent unequal expansion at the high temperature of the steam, while, at the same time, a clear throughway for steam is obtained, enabling the dimensions of the valve to be reduced to the minimum.

The expansion valve is controlled by a spring-loaded governor, which can be adjusted by hand while running, giving a variation of speed of 7 per cent. up or down from the mean.

The low pressure cylinder is fitted with a slide valve of the Trick type, compensated against the pressure of the steam on its back and against its own weight. The clearance spaces in the low pressure cylinder can be increased to prevent excessive compression when exhausting to atmosphere.

Both cylinders are steam jacketed, and automatic forced lubrication is provided. At the Exhibition the condensing apparatus has been omitted, the engine being connected with the main exhaust pipe and central condensing plant. Galleries are provided on the engine to facilitate access to the working parts, and handrails to protect the attendants from accidental injury.



Gutehoffnungshütte Pavilion: Riedler Express Pump driven by Helios Induction Motor.

We have already referred to the fine engine exhibited by the Gutehoffnungshütte, of Oberhausen, coupled to the large Lahmeyer alternator; we give on p. 665 a view of the engine from a better stand-point, and there follows a brief account of its main features. The engine is of the vertical triple-expansion three-crank type, designed for a normal load of 3,000 H.P. and a maximum of 3,500 H.P., at 94 revolutions per minute. The cylinders are respectively 830, 1,400 and 2,050 mm. in diameter, and the stroke is 1,200 mm. The working pressure at the stop valve is normally 165 lbs. per sq. in., but at the Essen Electricity Works, where it will be erected at the close of the Exhibition, it will work with an initial pressure of 125 lbs. per sq. in., condensing. The output, with cut-off at $\frac{1}{3}$ stroke, will be 3,000 I.H.P., and with $\frac{2}{3}$ cut-off, 3,500 I.H.P.

The bedplate is built up of three parts, bolted together, and weighing in all 17½ tons; each section carries one of the main bearings. The cylinders are supported on three massive cast-iron columns at the back, each of which weighs over 14 tons, and six bright steel pillars in front; they are firmly tied together, forming a rigid structure, not likely to be affected by vibration. The steel pillars can readily be removed, to allow of the withdrawal of any one of the cranks.

The main shaft is composed of three similar crank-sections, which are built up of separate parts, and are joined to one another and to the alternator shaft with flange couplings and taper bolts.

The cylinders are fitted with liners, and are jacketed both on their peripheries and at the ends with steam from the adjoining valve-chests. The steam is distributed to the high pressure and intermediate cylinders by valve gear on Prof. Gutemuth's patent system; the exhaust valves are operated by separate eccentrics. A horizontal shaft drives the gear on both cylinders, and is itself driven by a vertical shaft through machine-cut phosphor-bronze and cast-steel screw gear wheels running in oil. A Hartung spring-loaded governor is mounted upon the vertical shaft, and controls the cut-off of the high pressure cylinder; that of the intermediate is variable by hand.

The low pressure cylinder is fitted with ordinary positively driven Corliss valve-gear, operated by an eccentric from the main shaft. This cylinder was cast in one piece with the valve chambers and steam passages, weighing 24 tons in the rough.

The pistons of the high pressure and intermediate cylinders are heavy iron castings, so made in order to counter-balance the weight of the cast-steel piston of the low-pressure cylinder. The last is fitted with a modified form of Buckley piston rings, the others having ordinary self-acting rings. The engine is provided with gangways and galleries to give convenient access to all parts; and all the main stop valves for controlling steam and condensing water, pet cocks, oil pumps, &c., can be operated from the lowest platform. Oil is pumped from a sump to a reservoir on the top of the engine, whence it automatically gravitates to all the moving parts; the lubricators are of the drop-feed type, illuminated with glow lamps. The oil after use is collected and filtered, after which it returns to the sump.

Separate receivers are not provided between the cylinders, as the steam passages themselves are of sufficient capacity. Expansion joints are provided to enable the cylinders to expand independently without injury to the connections.

The weight of the complete engine amounts to 270 tons. It runs quietly and without vibration, while the high finish, in black and nickel, and bright steel, gives it a very handsome appearance.

The Gutehoffnungshütte possesses a very fine exhibit in a special pavilion, most of which, however, is not of an electrical description. We may, mention a horizontal blowing engine for a blast furnace, to be driven by blast furnace gas; this engine is of 1,000 H.P., running at 135 revolutions per minute, and is fitted with Stumpf's patent air valves. It is destined for the Eisenhütte, Oberhausen. The gas engine, which is direct coupled to the blowing engine, was manufactured by the Gasmotorenfabrik Deutz, and has four cylinders.

A horizontal tandem compound four-cylinder winding engine of 2,500 H.P., built by the Gutehoffnungshütte, is the central feature of the Pavilion, and is seen in the background of one of our figures, the foreground of which is occupied by a Riedler express pump of the same firm's manufacture. The latter is driven by a three-phase high-pressure motor built by the Helios E.A.G. The pump runs at 200 revolutions per minute, and is capable of lifting 2·5 m³. of water per minute against a head of 600 m. The plunger is 185 mm. in diameter, with a stroke of 250 mm. The motor is of the asynchronous type, and is supplied with current at 2,000 volts, 50 cycles per second; the normal

full load is 450—500 H.P. The stator is 2,680 mm. in outer diameter, 910 mm. wide, and the air-gap between stator and rotor is 1·75 mm. The rotor is provided with slip rings, and a device by means of which the winding can be short-circuited and the brushes raised when running.

An air compressor connected with the pump is shown in the same view, driven through toothed gearing by a Helios induction motor of 8 H.P. The necessary starting and measuring apparatus for these motors are mounted in a special housing close by; the starting resistance is of the liquid type. The large motor has a load factor of 83 per cent., and an electrical efficiency of 93 per cent. at full load.

(To be continued.)

ELECTRIC LIGHT AND POWER NOTES.

(Continued from page 662.)

Caerphilly.—It has been agreed by the U.D.C. to apply for a prov. order for electric lighting which will give the power of generating as well as distributing electricity, as it is thought that although these powers will not be actually required, they will be useful for the purpose of negotiations.

Londonderry.—A L.G.B. inquiry was held on 10th inst. at Derry, with regard to the Council's application for leave to borrow £35,000 for electric lighting in the city.

Manchester.—The electricity department of the Manchester Corporation has intimated to the Withington U.D.C. that no idea can be given as to when there is likely to be a reduction in the price of the electrical energy. Meantime, the controversy on the position of the Electricity Committee continues with unabated intensity.

Mexborough.—The U.D.C. has applied to the L.G.B. for a loan of £2,500 for electric lighting purposes.

Middlesbrough.—The T.C. has been invited to extend the lighting mains to Grove Hill, and has been advised by Mr. Hammond, the consulting engineer, that the extension would be remunerative. Nevertheless, the Council refuses to move in the matter, and the residents are deprived of the supply. Perhaps they will now correctly appreciate municipal enterprise.

New Forest.—The R.D.C. has decided to offer no opposition to the application to the B. of T. by the undertakers of the Lyndhurst Electric Lighting Order, 1901, for an extension of three months in which to carry out the work.

Newcastle-under-Lyme.—The T.C. has decided to dispense with the services of Messrs. Lacey, Clirehugh & Sillar, consulting engineers, and to appoint a resident electrical engineer to carry out the electric lighting scheme.

Queenborough.—The Kent Electrical Power Distribution Co. has asked the T.C. to support its application for a prov. order to supply the town with electricity for lighting and power purposes.

Rhymney Valley.—This valley includes a large number of collieries, and covers an immense and very populous area. The South Wales Electric Power Distribution Co. recently offered the U.D.C. to supply the district with electric energy in 12 months' time, provided the prov. order was got by the Council. A scale of prices was submitted for a quantity of 100,000 units. The figure was put at 1½d. per unit, or if supplied in bulk at any given three points in the Council's area, at a total cost of 2½d. per unit. The company purposes to erect a generating station at the bottom of Ebbw Vale, from which it will be able to supply Tredegar, Rhymney, Bedwellty, Blaina, Abertillery, Abercorn, &c. After careful discussion with Mr. Hill, the manager, on the general position, it was arranged that Mr. Hill should report on the cost of the scheme generally.

Romford.—The U.D.C. has engaged Mr. Hawtayne to advise on the offers received for electric lighting from the United Electric Light and Power Co.

Rugby.—The U.D.C. has decided not to erect a power station of its own, but to have the machinery fixed in the works of the British Thomson-Houston Co., with the condition that, after five years, the Council may, if it is so desired, remove the plant to a station of its own. The streets are to be lit by 20 arc lamps, and the private consumers will include Rugby School, which will take at least 40,000 units per annum.

Spain.—Under the title La Sociedad Electro-Popular, and with a capital of £150,000, a company has just been formed in Madrid to establish and operate a central electric lighting station.

Steyning East.—Brighton T.C. has informed the R.D.C. that it cannot supply electricity for lighting purposes outside its own area. The Rural Council has now asked the Corporation if it can supply the Council, providing the meter is within the Brighton district. This is certainly artful.

Stockton-on-Tees.—The Electricity Committee of the T.C. recommended the Corporation to supply energy to the R.D.C. at 4½d. per unit up to a minimum of 17,000 units per annum, for a term of 10 years. When the matter was debated on October 8th, it was pointed out that the Council did not hold the monopoly, as there was competition from the Electric Supply Co. As the terms were thought to be too high, the matter was referred back for reconsideration.

We see here very clearly how a municipality behaves when it thinks it has a monopoly. It charges as high a price as it dares—a quite absurd price, moreover, for a bulk supply. And yet we hear so much of the wicked company monopolists and the public-spirited municipalities!

Swansea.—The year's account shows a loss of £349 7s. 10d., including the sum of £143 10s. 4d. for sinking fund for March, 1901.

Swindon.—The B. of G. has decided to apply to the L.G.B. for a loan of £1,900 to cover the cost of the electric light installation at the workhouse. The tenders proposed to be accepted amount to £1,675.

Swinton (Manchester).—The B. of T. has called the attention of the Swinton and Pendlebury U.D.C. to the fact that it has not taken advantage of a prov. order granted in 1899 for supplying electricity. The Lancashire Electric Power Co. is prepared to supply the above and other districts in its neighbourhood by October 1st, 1903.

Tonbridge.—The U.D.C. has decided to supply electricity for power to large works in the town at 2d. per unit, provided that the proprietors repay the capital outlay, £400, in five years.

Tunstall.—The U.D.C. has decided to re-open negotiations with the Potteries Electric Traction Co. with a view to granting the company a licence to supply the district under the Tunstall Electric Lighting Order, 1900.

Wednesbury.—The Corporation has given instructions to Mr. F. J. Warden-Stevens, consulting engineer, to proceed at once with the necessary plans and specifications for the electricity undertaking in the borough.

Worcester.—The T.C. has decided to engage a staff of eight for the new electricity station, at a cost of £500 a year.

ELECTRIC TRACTION NOTES.

Alfreton.—Sir Bache Cunard has intimated to the U.D.C. his intention to apply for powers to construct a light railway through the district.

Altrincham.—In this district an opinion prevails that the local authorities, including those of Sale and Ashton-on-Mersey, should unite to form a tramway board for the construction of lines, under a provisional order, to be afterwards leased. Sale, however, is not prepared at present to entertain such a scheme. Any construction of tramways, in the absence of a working arrangement with Manchester, would be of doubtful advantage. The lines would run almost parallel with an existing railway, and Manchester would furnish the bulk of the traffic.

Amsterdam.—The Amsterdam Fire Brigade have decided to purchase a new electric automobile fire engine which will be capable of carrying nine men. The machine will be ready for use in a couple of weeks.

Ayr.—The Corporation have decided to proceed with considerable extensions. The salary of the tramway manager, Mr. Coutts, is to be increased from £200 to £250, while subordinate officials are also to receive increases, and the men to receive bonuses for length of service without faults.

Birkdale.—A curious dispute has arisen in connection with the laying of the electric tramway over the railway crossing at Aughton Road, Birkdale. The L. & Y. Railway Co. claim to have the control of the line for a certain distance on each side of the level crossing, while the British Electric Traction Co. object to the control going out of their hands. Meanwhile, until the matter is settled, the railway company have removed one of their lines. The Board of Trade inspection will not, probably, take place until an agreement is arrived at.

Bradford.—A fierce political controversy is raging in Bradford over the balance-sheet which has just been issued by the chairman of the Tramways Committee. The chief point made against the Committee is that it is only able to show a profit because the 1d. per unit which it pays to the Electricity Committee is less than cost, a statement which the Tramway Committee flatly denies.

Derby.—The elective auditors, in their report to the ratepayers on the town's finances, state that the cost of the horse tramways was £31,760, repayable in 40 years, at the rate of £421 4s. 3d. per annum. In 10 years the sinking fund would stand at £4,855. Then, with the present tramways reduced to scrap, the new electric

tramways would be burdened with the balance of £26,905 as unproductive capital. The failure of the electric lighting of the town was, they considered, due to the vast amount of unproductive capital wastefully expended, the excessive charges for coal, and the unreliability of the light supply. Their sympathies were with the Corporation, and they hoped that the £5,000 paid annually to the gas company would soon be transferred to the Electric Lighting Committee.

East Preston.—In reply to the B.E.T. Co., the R.D.C. has intimated that it is prepared to favourably consider any scheme of electric tramways from Worthing to Littlehampton.

Exeter.—With a view to the municipal reconstruction of electric tramways, the B. of T. has sanctioned the serving of purchase notices upon the owners of tramways in the city.

France.—The Bayonne and Biarritz steam tramway is to be converted into an electrically-worked line.

Gateshead.—At the Gateshead County Court on the 8th inst., before Judge Greenwell, James Rutherford, cab proprietor, sued the Gateshead and District Tramways Co., Ltd., to recover damages said to have been done to his cab by the negligence of the servants of the company. The plaintiff's vehicle and horses were on a return journey from Sheriff Hill on July 2nd, when they were run into by an electric tramcar and upset. The claim was for £22 14s. The evidence was that the car was going slowly, but the cab could not get out of the way owing to the crowd, and the driver held up his whip to stop the tramcar, but it was not stopped, and the two vehicles collided. Mr. Dixon, for the defendants, admitted the damage, and said it was a question whether the defendants' driver used sufficient caution. The plaintiff's driver ought not to have been on the tramway at all. His Honour: I cannot hold with you there. He had a right to be on what part of the road he liked. His Honour, in giving his judgment, said that it seemed to him the key to the position lay in the attitude taken up by the tram driver, that everyone must get out of the way of a tramcar. He wished to contradict such a view. The whole of the road was free for people to walk on or drive on, and the driver of the cab had a perfect right, especially in a crowd, to drive on the tramlines. He gave judgment for the plaintiff for the amount claimed with costs.

Halifax.—Sir Douglas Fox has advised the T.C. that it will be more economical to work the proposed tramway lift at Salterhebble, so as to avoid a precipitous incline on the route, by direct steam power, than by electrical power from the central station. The estimated cost of the lift is £10,500.

The T.C. has decided to extend the tramways to West Vale.

Huddersfield.—The following is a copy of the accounts of the Corporation Tramways Department for the six months ended September 30th, 1902. We learn that the improved results, as compared with the last balance-sheet, are due to an entire reorganisation of the department. Further than this, it should be mentioned that over £2,500 of revenue was lost owing to the roads on some sections being closed for reconstruction of permanent way, and that a shortage of rolling stock was experienced for three months on account of late delivery. The receipts were £26,506 10s. 3d. for 578,214 miles run, or 11·00d. per mile.

	£ s. d.	Pence per car-mile.
Maintenance and repairs—		
Rolling stock	1,973 5 9	·82
Engines and boilers	268 11 11	·11
Overhead equipment	126 4 8	·05
Generation of electricity	1,062 11 10	·44
	£3,430 14 2	1·42
Traffic—		
Motormen, Conductors, &c.	5,818 10 11	2·42
Oil, sand, &c.	397 8 7	·16
Uniforms	91 18 11	·04
	£6,307 18 5	2·62
Maintenance of works—		
Wages	26 7 4	·01
Materials	46 12 6	·02
	£72 19 10	·03
Maintenance of ways—		
Wages	281 15 7	·12
Materials	220 15 10	·09
	£502 11 5	·21
Management—		
Staff	584 6 10	·24
Borough fund	83 6 8	·04
	£667 13 6	·28
Rates, taxes, and insurance	£897 17 3	·37
Miscellaneous—Stationery, advertising, deputations, &c.	£576 12 7	·24
Depreciation	£3,500 15 0	1·45
Compensations	£375 0 0	·16
Interest and sinking fund	£10,007 15 4	4·16
Total expenditure	£26,339 17 6	
Expenditure		10·96
Income		11·03
Surplus		·07

For the steam section the expenditure was 15·67d. per cm., and the income 12·82d., showing a loss of 2·85d.

At a special meeting of the Town Council last week a resolution was moved and seconded for the appointment of a special committee to inquire into the general equipment of the tramways. The mover stated that the tramways had already involved the ratepayers in a debt of between £350,000 and £370,000, of which nearly £150,000 was already a dead letter. He commented also upon the serious loss by accidents. The chairman of the committee, in reply, stated that there had been a profit for the last six months upon the electric traction of close upon £200, and that during the month of September over 915,000 passengers had been carried without accident. The resolution was defeated, only two votes being given in its favour.

Crompton.—As 14 months of the two years granted under the prov. order to the U.D.C. for the construction of an electric tramway have elapsed, the Council is considering, in committee, a scheme estimated to cost £20,000.

Fairfield.—Messrs. Sterling & Swann have submitted to the U.D.C. a scheme of electric tramways from Chinley Station through Chapel-en-le-Frith to the Cat and Fiddle, returning by an alternative route to Spring Gardens, Buxton. The Council has expressed itself in favour of the scheme.

Ilkeston.—Sir B. Cunard has submitted to the T.C. an offer to lease the tramways at an annual rent of 7½ per cent. on the total expenditure. The Council has declined to entertain the offer.

L.B. & S.C. Railway and Electric Traction.—Upon inquiry the *Financial Times* has ascertained that the rumours regarding the intention of the L.B. & S.C. directors to lay a mono-rail electric line parallel with the present line are quite without foundation. "In other respects," says our contemporary, "electrification is not being neglected by the company. The nucleus of a big central power station already exists at Deptford, and more land is to be acquired there to so extend and amplify the installation as to render it capable of supplying all the current likely to be required for many years for power and light at the London Bridge and Victoria termini and the larger goods depôts belonging to the line in the metropolis. At the Deptford yards the very latest improvements are being put in, and all the big cranes, overhead traversers, shears and other lifting gear will derive their motive power in the future from electricity. The full effect of this comprehensive adaptation of the mechanical facilities of the yards to modern needs will not be felt for some time, but the fact that such drastic changes are taking place shows that the directors are at length becoming alive to the possibilities of electricity in connection with the working of a railway undertaking. There is also this to be said of the central power station that is to arise at Deptford, that in estimating its capabilities an eye has been kept on the probability of some portion of the company's suburban lines being electrified. It might be possible without excessive cost, as compared with the advantages to be derived from the transformation, to convert short stretches of track in the neighbourhood of the metropolis, and in that event considerations of economy would lead the directors to produce the necessary power at the existing station without adding the expense of erecting an entirely new depôt elsewhere to the outlay on conversion. No definite plans have yet, we believe, been formed respecting this likely development, but it is one which suggests a substantial contribution to the solution of the transportation problem in the environs of London."

London.—L.C.C.—At Tuesday's meeting the Highways Committee reported that as the erection of the projected power station at Greenwich would occupy a considerable time, they had considered the question of facilitating the adoption of electric traction on the second portion of the tramways pending the completion of the permanent station. It appeared that the London Electric Supply Corporation had plenty of space within the engine room at Deptford for the accommodation of additional machinery, and was willing for the Council to temporarily instal two of the sets of plant being built for the Greenwich station. The steam required for working the plant, for which the company would build the foundations, could be supplied from the Deptford boilers, payment being made to the company for the accommodation at the price of about 1½d. per unit generated. This was somewhat similar to the arrangement made with the South London Electric Supply Corporation in regard to the temporary plant at the station at Loughborough Junction, but, in the latter case, the County Council is to provide the buildings, cranes and boilers. It was anticipated that the generating sets proposed to be erected at Deptford would be completed and a supply of current available in about 10 months, and that the plant would thus be ready as soon as the work of reconstructing the tramways (the New Cross and Greenwich sections) had been finished. The total expenditure in connection with the temporary station was estimated at £17,100, and it was expected that, by proceeding with the work, a time economy of six months would be effected, whilst the permanent power station at Greenwich could, under the circumstances, be carried out with more deliberation, and at somewhat less cost, than would otherwise be the case. The Committee therefore recommended, and the Council decided to sanction, the expenditure, and to authorise them to enter into an agreement with the London Electric Supply Corporation, on the basis of a price not exceeding 1½d. per unit, for a period of from two to three years.

The desire of expediting the work of reconstruction of further sections of the tramways was referred to in another report by the Highways Committee, who thought it desirable that not only should provision be made for a penalty should the contractors exceed the period specified in the contract for the execution of the work, but also that a bonus of the same amount as the penalty

should be offered as an inducement to the contractors to complete the work at an earlier date. This course had been adopted by other public bodies to expedite the completion of works, and the Committee considered it to be expedient in the circumstances. Having regard to the large expenditure involved, the Committee proposed that the penalty and bonus should each be at the rate of £1,000 per week, and they recommended that a provision to this effect should be inserted in the contract for the roadwork for the New Cross and Greenwich sections of the tramways.

The Council adjourned for a week the consideration of a recommendation in favour of making a fresh application to Parliament for powers to construct a double line of tramways over Westminster Bridge along Victoria Embankment and that portion of the subway authorised by the Council's Act of 1902 between the Strand and the Embankment, to join at a point near the Strand the underground tramway authorised by that Act.

The electric car service of the L.U.T. lines in Acton Lane and at Shepherd's Bush was interrupted on the evening of Sunday. One of the mishaps consisted of the snapping of an overhead wire, and a lady who was passing at the time succumbed to heart disease.

Manchester.—A meeting of ratepayers was held last week, as required by the Borough Funds Act, in Manchester, to authorise the City Council to promote a Bill in Parliament next session. The Bill contains clauses relating, amongst other things, to the construction of additional tramways. One of the projected lines, through Victoria Park, was the subject of much opposition, various speakers urging that it was not needed either by the citizens generally or the residents whom it was expected to serve. The line was proposed to be laid along Anson Road, which contains only a limited number of residents, of the better class, who are strongly opposed to it. After a good deal of exciting discussion, the clause relating to the Victoria Park tramway was rejected.

Manchester and Salford.—A beginning was made, at the end of last week, with this tramway line, which is to connect the populous suburb of Prestwich with Manchester, through part of the intervening borough of Salford. It was intended originally that the Prestwich lines should be directly connected with the Manchester system, but the differences between the City Corporation and Salford prevented this, with the result that Prestwich was forced to make an arrangement with Salford, which is likely to prove mutually advantageous. The joining up of the metals at the boundary of the borough was attended with some little ceremony, the Mayor of Salford and other members of the Corporation being present. The chairman of the Prestwich District Council (Mr. Hislop) said the arrangement with Salford was to lay down a tramway line, at a cost of about £6,000, the Corporation taking it upon a lease for 21 years. Rails of British manufacture are being laid upon a solid bed of concrete. At a social gathering which took place after the ceremony at the residence of Mr. Hoyle, a member of the Prestwich Council, the good relations between Salford and Prestwich were made a subject of congratulation, and confidence was expressed in the tramway investment yielding a satisfactory return. The Mayor of Salford said the results of the tramway undertaking in the borough were in every respect satisfactory. Alderman Linsley added that an estimate made last March of the probable receipts on the Eccles route, for a period of 12 months, had already been exceeded by nearly £7,000.

Melbourne.—The Minister of Railways was engaged on September 1st in considering offers made to him by private firms in connection with the proposed conversion of the suburban railway system to electricity. According to the *Melbourne Age*, Mr. Bent has received a communication from a company which is prepared to undertake the conversion of the whole of the suburban railway system at about one-half of the cost as estimated by the engineer-in-chief of the Railway Department. The company's estimate includes the cost of rolling stock. "It is perfectly evident," says Mr. Bent, "That a number of people are anxious to undertake the conversion of our railway lines if we do not wish to carry out the work ourselves. The company I speak of will carry out the work at half the cost as estimated by the engineer-in-chief of the Railway Department, and it is willing to accept payment for the work in Government debentures. Surely that is an offer worth considering." The offer will be brought before the Cabinet immediately. Another offer has been made to the Minister in connection with the proposed construction of an electric line from St. Kilda to Brighton. A syndicate has informed Mr. Bent of its willingness to construct the line immediately, without any Government assistance, if the Government will grant it the use of the railway for a certain number of years, the line after that time to revert to the Government. Both these offers, Mr. Bent says, are backed by substantial guarantees, and the Government will give them careful consideration.

New South Wales.—The annual report of the New South Wales Railway Commissioners on the working of the Government tramways shows that on June 30th, 1902, 104 miles of line were open for traffic, and many miles of steam and electric lines were being constructed.

Considerable improvements have been made on the North Shore lines. The car shed has been added to and modernised. Two battery rooms have been provided; the engine room has been converted into a sub-station, and a balloon loop has been put in at Mosman's Bay. At Waverley a sub-station has been erected, and a car shed, capable of holding 187 cars, is in course of construction; also, at Randwick, electric repair shops and a paint shop are being provided. During the year 13 electric cars were paid for out of working expenses, to replace a similar number of old steam cars and two motors. The steam stock replaced to date by new electric cars paid for out of working expenses amounts to 87 cars and 10 motors at a cost of £63,877. Ninety-eight additional electric motor cars and seven service trucks have been added to stock and charged to capital account, and a further supply of cars are now being constructed to meet the additional traffic requirements and to complete the conversion from steam to electric. The number of passengers carried during the year was 108,135,111, as compared with 93,703,685 in the preceding year, the increase being 14,431,426, although last year there was an abnormal increase of 27,459,351, due to some extent to the Commonwealth celebrations and the visit of the Duke and Duchess of Cornwall and York. The city and suburban steam and electric lines (combined), also the North Shore electric lines, show decreased net results, although the gross revenue in each case has considerably increased, but not to the extent of fully meeting the additional expenditure in connection with the more frequent service rendered to the public.

The conversion of the western suburban lines, with the exception of the branch lines, Ashfield—Enfield, Burwood—Mortlake, and the Abbotsford lines, from steam to electric, have been completed, and it is hoped that the eastern suburban system will be similarly dealt with during the next few months.

The extensive addition to the power house at Ultimo has been almost completed, and two of the vertical engines of 2,300 (full load) I.H.P., each directly connected with 1,500 KW. alternating-current generators, are at work, and the third, with the necessary electrical equipment, will be ready for use in a few weeks. In connection with this plant, 24 Babcock & Wilcox water-tube boilers, of 250 nominal H.P. each, working at 160 lbs. pressure, have been installed.

The increases granted to the staff during the year involved an additional expenditure of £53,750, of which £49,274, or 91·67 per cent., was given to the wages staff, and £4,476, or 8·33 per cent., to the salaried staff, principally to employés engaged in working the traffic. On June 30th last the staff numbered 18,574, being 2,324 in excess of the previous year. This large increase is mainly due to the growth of the railway and tramway business, and to some extent the reduction of the hours of labour and improving the conditions of the employés have contributed.

Paris Metropolitan Railway.—The second Metropolitan line was opened to the public last week. The station of the Place Clichy will be opened about 20th inst.

Rochester.—The T.C. is now discussing the proposed electric tramways for the city and district, and lengthy reports have been submitted to the Corporation for consideration. The remuneration of Mr. E. Rotter, the tramway engineer, is to be 3 per cent. on all tramway expenditure for new works, such remuneration to cover services for self and his staff with expenses. Should the Corporation fail to obtain the necessary Parliamentary powers, 150 guineas is to be paid to Mr. Rotter in full discharge of all claims for services and expenses. Mr. Rotter has submitted an approximate estimate of the proposed scheme:—

Power station site	£6,500
Power station buildings and car shed, &c.	14,000
Power station plant	15,000
Electric motor cars	14,500
Feeder system	3,800
Permanent way and overhead equipment:—	
No. 1 Tramways	33,713
„ 2 „	10,944
„ 3 „	17,052
„ 4 „	9,668
Approach to depôt, track work, and overhead equipment	1,083
Total	£125,960

Shanghai.—We hear that the offer of the Brush Electrical Engineering Co. to establish tramways in Shanghai has been accepted by the municipality. The Brush Co. has recently acquired the concession for the city of Bombay for tramways, lighting, and power.—*Indian Engineering.*

Sheffield.—The Tramways Committee is making satisfactory progress in building the bodies of tramcars. At the works at Nether Edge there are now half a dozen cars in various stages of manufacture, and six single-deck cars have already been completed. The authorities have undertaken to turn out six double-deckers and 12 single-deckers by April. At present there is room at the works to allow of six cars being taken in hand simultaneously, but provision is to be made for four more almost immediately. The whole of the power and light is supplied by electricity, the current coming from the tramway circuit.

The chairman of the Tramways Committee has offered £10,000 to the Corporation out of tramway profits to be devoted to the relief of rates, and the Finance Committee has brought the district rate down to 2d. less than it had recommended.

South Shields.—A meeting of the Parliamentary Committee has been held to consider the Bill that that authority is preparing to lay before the next session of Parliament. The town clerk has received a reply from Mr. Lewis Coward, K.C., regarding the clause to be inserted in the Corporation's tramways Bill undertaking that, before it was decided either to lease or municipalise the tramways, a poll of the ratepayers would be taken. It is stated that Mr. Coward has expressed his opinion that the House of Commons would

never accept such a clause, and that it would jeopardise the whole Bill. The British Electric Traction Co. has written to the Committee stating that it is preparing a Bill for next session for powers to lay down a system of tramways from Whitburn to South Shields, similar to that proposed last year, and it is also seeking powers to lay a line to the borough boundary, down Fowler Street, across King Street, to a point in the Mile End Road, near to the terminus of the proposed electric "tube." A joint meeting of the Tramways Committee and the Parliamentary Committee is to meet the representatives of the company, but, before doing so, the company is to state its proposals more definitely.

Southport.—The tramways extension is being commenced. The length of the new route, including Duke Street, Shakespeare Street and Cemetery Road, is about 1¼ or 1½ miles, and the total cost will be approximately £10,000. Powers to proceed with the work were obtained in August, and borrowing powers for the requisite amount of capital in September. No additional cars will be purchased for the new route. It is anticipated that the line will be in working order by the middle of December.

Stretford.—The suburb of Stretford, which is increasing rapidly in population and commercial importance, is in a somewhat delicate position with regard to its tramways. Until now a horse-traction system only has been worked, under an arrangement with the Manchester Carriage and Tramways Co., who own the lines. Negotiations are in progress for the purchase of these old lines by the District Council, in order that they may be adapted for electric traction, but delays have occurred which have caused much local dissatisfaction. Ultimately the lines through the district will be worked by the Manchester Corporation. A city line, up to the Stretford boundary, will be completed and opened at the beginning of December.

Surrey and Sussex.—The Light Railway Commissioners, sitting at Cranleigh on October 9th, decided that the scheme promoted by the Rural Railway Co., Ltd., was too incomplete, and declined to sanction it. It was stated that the incompleteness of the scheme was due to the opposition encountered.

Swinton.—Salford T.C. has informed the U.D.C. that it will proceed to construct the electric tramway to Swinton and Pendlebury forthwith, and that it will be completed by the middle of February next.

Syndey (N.S.W.).—We read in the *Melbourne Age* that the Lombard—Gerin electric traction system (trolley line without permanent way) is to be tried experimentally in Sydney on the recommendation of Mr. Deane, engineer-in-chief of railway construction. The Government would furnish the necessary energy, and if the line works satisfactorily for 12 months the question of taking the line over would be considered.

Walsall.—The National Electric Wiring Co. have completed their contract for the overhead electric equipment of the new Bloxwich section of the tramways. The borough electrical engineer has been requested to submit to the Council a design and specification of a car somewhat similar to those in use in Manchester, but with reversed staircase.

Warrington.—The Wilderspool section of the electric tramways which has just been opened, was estimated to cost £13,500. The actual cost has been £11,770.

Whitworth.—The B.E.T. Co. has informed the U.D.C. that it has come to the conclusion that there will not be sufficient traffic to justify it in incurring a large expenditure in constructing an electric tramway from Bacup through Whitworth to the Rochdale boundary. It, therefore, does not feel disposed at the present time to take up the scheme.

TELEGRAPH AND TELEPHONE NOTES.

Cablegrams by Telephone.—The Glasgow Chamber of Commerce, who have been pressing the Postmaster-General for the underground cable between Glasgow and London, have decided to petition for equal facilities with Liverpool, London and Manchester, for cable companies in Glasgow to accept cablegrams by telephone. At present the companies are restricted in this matter.

Christchurch Telephones.—The T.C. has decided, subject to the consideration of details, to co-operate with Bournemouth Corporation in establishing a municipal telephone exchange.

Pacific Cable.—Reuter's agent at San Francisco reports the representatives of the Pacific Commercial Cable Co. as saying that the plan for the cable between Honolulu and Fanning Island, as proposed by the Government of New Zealand, has been practically agreed upon.

Portsmouth Telephones.—The Postmaster-General has agreed to the collection of tolls and to the rendering quarterly of the total of the fees on local calls.

Swansea Telephones.—At the Guildhall on Tuesday last week, Mr. J. C. Pottinger, M.I.C.E., held an inquiry into an application that has been made to the L.G.B. for sanction to borrow £20,300 for the establishment of a municipal telephone system in the borough and surrounding districts.

Mr. Wheatley said the Swansea scheme originated in complaints made by the Chief Constable as to the working of the police telephone system, which was reported upon as being behind the times by the borough electrical engineer, Mr. J. H. Cawthra. Proposals for a more efficient service were suggested, but on the initiative of Councillor Solomon, a municipal system was decided upon, for the purposes of which Mr. Bennett, of Glasgow, had favourably reported. At the time of this report the National Telephone Co. had 650 subscribers, or one subscriber for every 231 of the inhabitants, compared with one subscriber for every 14 inhabitants in Sweden, Norway and Denmark, where the telephones were cheaper and more up to date, or one subscriber to every 40 persons in Guernsey. The reason for the small number of subscribers in the Swansea area seemed to be due to the prohibitive rates at present charged, £9 being charged within the area, and as much as £16 being often charged for the outside districts. The result, in the words of the engineer's report, had been that "we have had (in Swansea) a mere scratching of the telephone field and no more." If Swansea had the same proportion of subscribers as that at Guernsey, the number of subscribers would be 3,750, while if it had the proportion of Norway and Sweden the number would be 10,714. The Postmaster-General's licence had been obtained to the scheme, as well as the consent of the County Councils concerned, while the Postmaster-General had further consented to a minimum rate of £5 for an unlimited service, so that the National Co. would not be in a position to under-cut the rates. The site of the proposed telephone exchange in Swansea was in Pier Street—a central position—and the contract for the erection of the building had been let in order to avoid delay. The work had been begun. The amount of the tender was £2,297 10s. He went on to mention that at a recent fire the police telephone service failed to work, and consequently great pressure was being brought upon the Corporation to proceed with the work as soon as possible. Already 337 persons or firms had applied for an unlimited service at the rate of £5 per annum, while 57 had applied for lines at the rates to be charged by the Corporation, £3 per annum and 1d. per call. No less than 33 per cent. of the National Co.'s subscribers had signified their intention of coming over to the municipal service, while the rateable value of the promised subscribers represented £89,631 7s. 6d. No contracts had been let for plant, "but," said Mr. Wheatley, "they probably will be let to-morrow."

Mr. Bennett, consulting engineer, explained the proposed system, stating that there would be switch stations, by means of which connections could be made with outside areas, at Pontardawe, Clydach, Morriston, Skewen, Pontardulais, Gorseinon, Gowerton, Loughor and Mumbles. The actual number of lines provided for on the switchboard was 750, but the board had been designed so as to extend the number of lines to 3,000. Glasgow a few years ago started its municipal telephone system with 3,000 promised subscribers, while to-day it had over 4,000; at Tunbridge Wells the station had grown in a year from 700 to 920 subscribers.

Major-General Webber gave it as his opinion that local authorities should own their telephones, not only for the benefit of urban districts, but also the much-neglected rural districts. He confirmed the reports and estimates of Mr. Bennett, and expressed his belief that the municipal system would successfully compete with the National Telephones. He corroborated Mr. Bennett's opinion that the system could pay its way.

Mr. Bennett, recalled, stated that by the system with underground cables, which he proposed in Swansea, it would be impossible except in case of accident for one subscriber to hear the conversation of another. "Tapping" on the part of the telephone girls would also be impossible.

Councillor W. H. Mill put two questions, the replies of Mr. Wheatley to which went to show that the National Co. intended coming within the Telegraphs Acts, 1899, in Swansea; if they did, and the Swansea Corporation had half the number of the subscribers, the National Co. would be compelled to allow inter-communication free of charge. The Corporation had already more than the requisite number of subscribers for this purpose. Furthermore, the Corporation had given underground wayleaves to the company, and unless they came within the Act the notices terminating those wayleaves would be enforced. As to the charges, the Corporation system would be £3, as against £3 10s. charged by the National Co., and 1d. per call in each case within a mile radius. The inquiry was closed.

Telegraphic Interruptions and Repairs :—

Cables.	Interrupted.	Repaired.
Latakia-Cyprus	June 20, 1899 ..	..
Communication with Carthagena and Barranquilla (Columbia)	Dec. 8, 1900 ..	..
Trinidad-Demerara No. 1	Aug. 27, 1901 ..	..
St. Lucia-Grenada	May 8, 1902 ..	Oct. 13.
Dominica-Martinique	May 8, 1902 ..	..
St. Lucia-Martinique	May 8, 1902 ..	..
Guadeloupe-Martinique	May 9, 1902 ..	..
Santa Cruz de Teneriffe to Tejita de Teneriffe	July 4, 1902 ..	..
Puerto Plata-Martinique	July 10, 1902 ..	..
Guantanamo-Mole St. Nicholas	Aug. 4, 1902 ..	..
Cayenne-Pinheiro	Aug. 13, 1902 ..	..
St. Lucia-St. Vincent	Sept. 19, 1902 ..	..
Landlines :—		
Route *via* Hanekin on Persian territory	Feb. 24, 1900 ..	..
Communication with Tientsin and Taku *via* Helampo	July 18, 1900 ..	..
Communication with Maranham	Sept. 19, 1902 ..	..

The Telegraph Wire Export Trade.—Not for a long time has the export trade of this country in telegraph wire and apparatus connected therewith been so quiet as during the past

month. The shipments only attained a value of £50,739 as compared with £391,207 in the preceding month, and £80,294 in September, 1901. For the nine months ending with September last, the returns show a total of only £2,226,732 which compares with £2.753,152 in the corresponding period of last year, and £2,469,476 in the first nine months of 1900.

Wireless Telegraphy.—The *Western Electrician*, of Chicago, says "that Rear-Admiral Royal T. Bradford, chief of the Bureau of Equipment of the United States Navy, under whose supervision tests in space telegraphy have been going on between the Washington Navy Yard and the Naval Academy at Annapolis for some time, says that 'No reliable system of wireless telegraphy has yet been developed.' The results obtained from the tests made with the different systems are not made public, but it seems to be evident that no system proved sufficiently reliable to warrant its adoption by the Navy Department. The recent army and navy manœuvres demonstrated the need of a 'wireless' system, and investigation will not cease until that need is supplied. The training ship *Prairie* has been ordered to report to the board conducting the tests, the intention being to send the vessel out into Chesapeake Bay and exchange messages between it and the station at the Naval Academy. The plan followed will be similar to that which would be required in time of war between a defending squadron and shore fortifications. Upon the conclusion of these experiments, one of the ships of the North Atlantic squadron will be equipped with the system which has given the best results, and, with the *Prairie*, will be sent to sea. Communications will be carried on between the two ships as between a flagship and the ships of a fleet, and the defects and advantages of the system noted. None of the systems tested so far has given satisfactory results over a distance of 50 miles, and the question of interference remains to be solved. Rear-Admiral Bradford had hoped to obtain a satisfactory system and equip the ships which will participate in the impending winter manœuvres with it. This, however, will be impossible, judging from the results obtained in the recent tests."

Italy and Argentina have agreed, according to the *Chronicle's* correspondent at Rome, to establish stations for wireless telegraphy between the two countries. Signor Marconi estimates the cost at £50,000. Wireless despatches will cost 1 lira per word, instead of 6 lire, the cost of present cablegrams.

The conference on wireless telegraphy proposed by Germany will probably collapse, the correspondent thinks, as France, England, Russia, and Italy have not yet answered the German proposal.

The official report of the experiments in wireless telegraphy carried out on board the Italian warship *Carlo Alberto* during July, August, and September of this year has been sent by Signor Marconi to the *Times*.

CONTRACTS OPEN AND CLOSED.

OPEN.

Aston Manor.—October 31st. Condensers for electricity works. See "Official Notices" October 10th.

Batley.—October 28th. Cooling tower and tank for the electricity works. See "Official Notices" October 10th.

Brussels.—The Belgian Telegraph and Telephone Departments are about to make the following purchases:—120,000 kilogrammes of galvanised iron, 650,000 metres of copper wire, about 100,000 iron plates, 65,000 telephone and telegraph insulators. The iron being for the manufacture of wire, should be of first quality; the surface should be galvanised with pure zinc, and the section should be perfectly circular. The wire must be capable of a resistance of 46 kilogrammes per square millimetre. Under a load of 20 kilos per square millimetre, it should not be extensible by more than 2 per cent. The electric conductivity of the iron should be not less than $\frac{80}{100}$ths of that of pure iron.

Burton-upon-Trent.—November 5th. Overhead equipment for tramways. See "Official Notices" to-day.

Copenhagen.—November 17th. Two dynamos, switchboard, &c. See "Official Notices" to-day.

Dudley.—October 18th. Arc lamp carbons. See "Official Notices" October 3rd.

Dumfries.—The T.C. has resolved to call for tenders (1) for the lighting prov. order; (2) for both the lighting and the traction orders; (3) for a supply of electricity to drive the cars; (4) if the Council constructs the works, for the lease of each.

Hammersmith.—October 24th. Electricity meters. See "Official Notices" to-day.

Hornsey.—October 27th. The Council wants tenders for the fitting up of an electric light installation in its electricity works. Specifications, &c., from Mr. Robert Hammond, consulting engineer, 64, Victoria Street, S.W. Deposit, £1.

Ipswich.—October 22nd. (*a*) Switchboard, motor boosters, and connections. (*b*) Overhead construction for tramways. See "Official Notices" September 26th.

Lancaster.—The Visiting Committee of the County Asylum invites tenders for a new direct-coupled dynamo (700 16-C.P.) and switchboard. Particulars from Medical Superintendent.

London.—October 21st. Two electric car traversers for the L.C.C. tram depôts. Specifications, &c., at Spring Gardens, £2.

Mansfield.—October 31st. Electric wiring of the Town Hall. Specifications from Mr. Hewlett at the electricity works.

Newcastle-upon-Tyne.—November 8th. A triple-expansion direct-coupled 3,000-H.P. engine for the Corporation tramways station. Mr. A. E. Le Rossignol, general manager and engineer. Deposit for specifications, £3 3s. See "Official Notices" to-day.

Paris.—October 27th. Competition for supply and installation of motors, pumps and generators for water-works. —Apply Hotel de Ville, Paris.

Santiago de Cuba.—November 15th. The Municipality of Santiago de Cuba is open to receive offers for installing an electric lighting system in the town.

Shanghai.—October 30th. (*a*) Two 500-KW. steam alternators; (*b*) switchboards; (*c*) two condensers and pumps. See "Official Notices" September 12th.

Spain.—October 19th. Tenders are being invited until the 19th inst. by the municipal authorities of Irun (Guipuzcoa province), for the concession for the electric lighting of the town. Tenders are to be sent to El Secretario del Ayuntamiento de Irun (Guipuzcoa), whence particulars may be obtained.

Spain.—October 20th. The municipal authorities of Bonillo (province of Albacete) are inviting tenders until the 20th inst. for the concession for the electric lighting of the town during a period of 20 years. Particulars may be obtained from, and tenders are to be sent to, El Secretario del Ayuntamiento de Bonillo (Albacete).

St. Petersburg.—November 1st (14th). The T.C. invites tenders for the reconstruction of the three town tramway lines, hitherto worked by horse traction, with electrical power, and the construction of an electric station. The terms of the tender, also application forms with particulars, will be sent free at once either by post or wire. The last date for the production of projects and offers is as above, and applications should be addressed: Stadt Amt, St. Petersburg, Russia.

Sunderland.—November 28th. Steam dynamo, three-phase motor-generators and transformers, and switchboards. See "Official Notices" to-day.

Swindon.—October 29th. Electricity meters. See "Official Notices" to-day.

Tien-Tsin.—November 30th. The Municipal Secretary at Tien-Tsin is calling for proposals for the lighting of the British concessions by electricity. See this column for August 15th.

Wakefield.—October 18th. Electrical installation for the old workhouse buildings for the Guardians. Clerk, Union Offices. Specifications, one guinea.

Wigan.—October 20th. (*a*) Electrical equipment of a short length of new tramway and a portion of the existing line; (*b*) construction of same; (*c*) 18 bogie cars, double-deck, four motor. See "Official Notices" September 26th.

CLOSED.

Bexley.—The U.D.C. has given a contract to Messrs. Johnson & Phillips, for switchboards at £1,049, and for transformers, pillars, &c., at £1,155.

Bradford.—The Markets and Fairs Committee has accepted the tender of the Bradford Electrical Engineering Co. for electric light fittings for the Market Tavern and the Trevelyan Hotel, at a cost of £170 15s.

Glasgow.—The Committee of the Glasgow Parish Council has recommended the acceptance of the tender of Messrs. Arnott and Co., Coatbridge, for the large new Lancashire boilers, &c., in connection with the hospital in the eastern district, now building. Mr. A. H. Tiltman, of London, is the engineer and architect.

Gravesend.—The T.C. on October 8th accepted the tender of Messrs. Gardener & Co., for wiring the market and municipal buildings for the electric light at £396. The Alliance Electrical Co. tendered at £400.

Huddersfield.—The Tramways Committee has accepted the following tenders:—For copper bonds, F. A. B. Low; points and crossings, Askham Bros. & Wilson; ¾ and ½ in. racking, J. W. Smith & Co.; cement, Otto Trechmann, Ltd.; pitch and oil, Henry Ellison.

The tender from Mr. E. Nuttall for the reconstruction of the permanent way of four extensions within the borough has also been accepted.

Liverpool.—The T.C. has accepted the tender of Messrs. Galloways, Ltd., of Manchester, for the supply of 14 Lancashire steel boilers for the electric light stations, at £735 each.

Newport (Mon.).—An order has been placed with Messrs. Markham & Co. by the Corporation Electricity Committee for a third engine for their power station, Messrs. Markham's tender being £4,200. The same firm are to be paid £100 as compensation for delay in accepting delivery of two engines previously contracted for, and for warehousing them.

Peterborough.—Messrs. Pritchetts & Gold have obtained a contract for a storage battery of 240 cells to be used in connection with a Crompton automatic reversible booster for the Corporation's new traction station.

Portsmouth.—The T.C. has endorsed the recommendation of the Tramways Committee that the tender of the Britannia Co., £90, be accepted for the supply of overhead line material. The other tenders were:—Electric Tramways Equipment Co., Ltd., £83 15s.; Macartney, McElroy & Co., £90; Dick, Kerr & Co., £90; R. Blackwell & Co., £100 16s.

Rugby.—The U.D.C. has accepted the tender of the British Thomson-Houston Co., for the supply of engines, dynamos, and switchboard for the new electricity works.

Stepney.—The M.B.C. has accepted the tender of Messrs. J. & H. Gwynne for a centrifugal pump for the electricity works, at £58 12s.

FORTHCOMING EVENT.

Tuesday, October 21st.—At 2 p.m. Institution of Junior Engineers. Visit to the London Bridge Widening Works.

REVIEW.

Modern Iron Foundry Practice. Part I. By G. R. Bale. London: The Technical Publishing Company, Limited. 1902. Price 5s.

This volume is intended to meet the existing want of a manual on this subject, and is of interest mainly to those engaged in iron foundries. There is, however, a good deal of matter relating to electrical apparatus, such as cranes, fans, lifting magnets, &c., which appeals to electrical engineers. Illustrations and particulars are given of some of these valuable aids to foundry work. As was inevitable, the electric driving of cranes is eulogised as being far in advance of all other means for the purpose, and it is pointed out that owing to the introduction of electricity primarily for this object, it has obtained a firm foothold in the foundry, where it is now made use of for all kinds of purposes.

The bulk of the volume deals with actual foundry equipment, materials and processes, in a most practical manner, and the volume it will no doubt form a valuable addition to the engineer's library.

NOTES.

Will.—The estate of the late Mr. Arthur Dennis (W. F. Dennis & Co.) is valued at £32,582 gross, and £29,862 net.

Institution of Electrical Engineers (Manchester Section).—The Committee of this section for the approaching 1902—1903 session is as follows:—*Past-Chairmen:* Dr. Edw. Hopkinson, C. H. Wordingham. *Chairman:* Hardman A. Earle. *Vice-Chairman:* Edw. W. Cowan. *Members:* Dr. F. H. Bowman, S. V. Clirehugh, A. A. Day, C. M. Dorman, W. P. J. Fawcus, A. S. Giles, J. S. Highfield, H. Lindley, G. F. Metzger, A. B. Mountain, Dr. C. H. Lees, C. D. Taite. Mr. Cowan has vacated the post of honorary secretary, and, as above stated, has been elected vice-chairman. Mr. P. A. Ramage, Salford Iron Works, Manchester, is the new hon. secretary and treasurer, and all communications relating to the section should in future be addressed to him. The last report states that, if sufficient students come forward next session, it is proposed to form a students' sub-section.

Institution of Civil Engineers.—The Council of the Institution of Civil Engineers has, in addition to the medals and prizes given for communications discussed at the meetings of the Institution in the last session, made the following awards in respect of other papers dealt with in 1901—1902:—A Telford gold medal to J. Macfarlane Gray (London); a George Stephenson gold medal to R. Price-Williams (London); a Watt gold medal to W. Bell Dawson, M.A., D.Sc. (Ottawa); Telford premiums to W. R. Cooper, M.A., B.Sc. (London), E. M. De Burgh (Sydney, N.S.W.), George Wilson, D.Sc. (Manchester), Frank Oswell, B.A. (Buenos Ayres), A. W. Brightmore, D.Sc. (London); a Crampton prize to C. D. H. Braine (Mowbray, Cape Colony); the Manby premium to B. W. Ritto (Cape Town). For students' papers the awards are:—A Miller scholarship (tenable for three years) and the "James Forrest" medal to H. F. Lloyd (Birmingham); Miller prizes to J. C. Collett and W. H. C. Clay (London), H. C. M. Austen (London), A. M. Arter (London), Robert Bruce (Manchester), L. F. Wells, B.Sc. (Manchester), W. H. McLean (Glasgow).

Shock Fatalities.—On the 7th inst. a pitman in the Philadelphia Pit, Durham, received a fatal electric shock from a cable that had been broken in the pit by a fall of stone. The deceased man (Thos. Bellemy) was working in the pit, when a tub got off the line, and he went to help another man to get it on again. While they were working, a slight fall of stone came away from the face of the coal, and fell on to the electric cable, snapping it; one part of the cable springing back struck Bellamy on the left arm, and he received an electric shock, and almost immediately fell dead. At the inquest Dr. D. R Boyle said that death was due to paralysis, following on an electric shock. Mr. Austin Kirkup, manager, said the cable was insulated by india-rubber, and there was no fault until the stone came away. A verdict of accidental death was returned, no blame being attachable to anyone.

Early in September a coolie, Juggoo Gowala, working on the platform of a telescopic ladder at Calcutta, received a fatal electric shock by coming into contact with the wires of the Calcutta Electric Supply Corporation. He was stooping under the wires when his back touched both the positive and negative wires, and he fell down senseless. The medical evidence showed death to be due to sudden failure of the heart, caused by electric shock.

At Melbourne recently a bricklayer named Fellows was removing his coat to set to work upon cleaning out a transformer pit, and in stretching out his left hand, unwittingly touched a live wire, and succumbed to the shock. His brother, who was at work with him, attempted the work of restoration, but without success. Fellows's left hand was badly burnt, and there was a large patch on the back of his head.

On 10th inst. a man named Jones, who was employed by Callender's Co. repairing a feeder pillar for the Sutton Coldfield Corporation, received a fatal electric shock.

The Glasgow Tram Accident.—The Board of Trade report on the car collision which occurred in Renfield Street, Glasgow, on September 6th has been published, but space will not allow us to reprint it this week. It will duly appear in our next issue. The report goes to emphasise the important lesson of "the necessity of having highly trained and intelligent, level-headed men as drivers." When one of the drivers was confronted with an emergency, Major Druitt thinks it probable that he "failed to use properly the brake especially provided for an emergency."

South African Trade.—Messrs. Ben Morgan and T. N. Jenkin, who recently returned from their South African trade tour, submitted their reports at a meeting of the South African Trade Committee held at Palace Chambers, Westminster, on 8th inst. Mr. John Lockie, J.P., presided. Mr. Ben H. Morgan, the Engineering Trades Commissioner, stated that there were enormous opportunities for trade in engineering lines. In regard to the industry of the Rand, he was of opinion that a large quantity of mining and electrical machinery of all kinds would be required. Bright prospects were held out to manufacturers of steam engines and general tramway and lighting equipment for towns. He dealt in detail with the prospects of trade in iron and steel constructional work. He found that German and American competition was everywhere very keen, and, although the prospects of trade were so good, business could only be obtained by enterprise and pushfulness, and a thorough appreciation of the requirements of the market. He hoped that the exposure of antiquated methods of business in his report would open the eyes of British manufacturers and traders, and help to bring about a better condition of things.

Düsseldorf Exhibition.—The Berlin correspondent of a financial contemporary says that an Anglo-American Industrial Co. at Buenos Ayres has sent a Commission to inspect the Düsseldorf Exhibition, and that as a result of the visit this Commission has placed large orders with several German firms. Thyssen & Co., at Muelheim-am-Rhein, are said to have received a large order for iron pipes; the Aachen Electricity Co. is to supply an electrical central station and some electric motors. The Frankfort Machine Works, Wiesche & Scharffe, has received a commission to supply heavy electrical lifts and cranes; the Schwiderski firm at Leipzig is to supply two powerful steam engines, and the Düsseldorf-Ratinger Tubular Boiler Works are to provide the steam installation work.

Obituary.—The inquest into the cause of the death of Dr. J. H. Gladstone, F.R.S., to which we referred last week, showed that he was found dead on the floor of his study at Bayswater. It seems that he had just previously returned home on Monday evening, last week, from a meeting of the Christian Evidence Society over which he had been presiding. The medical evidence showed that there was extensive old pleurisy on the left side, so that he could hardly use one lung. The valves of the heart were a little diseased. Death was due to syncope from a weak heart and old pleurisy.

We regret to record the death of Mr. Joseph Beattie, a partner in the firm of Warren, Beattie & Co., electrical engineers, Middlesbrough, at the early age of 27 years. Mr. Beattie had been ill for some time past.

The death is announced, as having occurred on 13th inst., of Mr. Peter Brotherhood, the well-known high-speed steam engine builder, of Belvedere Road, S.E. Mr. Brotherhood, who was 64 years of age, passed away at his residence in Hyde Park Gardens.

Personal.—Mr. J. H. Leake has been appointed mechanical and electrical engineer to the West Riding of Yorks Asylums Committee.

The *London Gazette* for Friday announced that Lieut. A. P. Trotter has resigned his commission in the Electrical Engineers, R.E. (Volunteers).

Mr. Ernest Browne, lately with Messrs. Ernest Scott & Mountain, of Newcastle-on-Tyne, and district engineer and manager for the National Electric Wiring Co., Ltd., of Victoria Street, Westminster, S.W., has accepted a position with the Britannia Electrical Works Co., of St. Martin's Lane, W.C., as chief assistant engineer.

The *Referee* says:—"Mr. G. Applebee-Poynton, the electrical engineer to the Gaiety Theatre, is one of the few members of the theatrical profession to receive the Coronation medal. Company-sergeant Major Poynton was the senior N.C.O. of the Corps of Electrical Engineers R.E. Volunteers on duty for the Coronation procession on August 9th."

We understand that Mr. A. A. King, who has been chief representative for Messrs. Veritys, Ltd., of Manchester, has severed his connection with that firm.

Exhibition at Grimsby.—Under the auspices of the Grimsby Electric Lighting Committee, an interesting exhibition was held at the Town Hall last week, with a view to showing that electricity can be utilised not only for illumination, but for heating and cooking purposes. The E.L. Committee, the tramway company, and other tradesmen who deal with electric plant had stalls and exhibited their particular wares. The whole of the arrangements were successfully carried out under the able guidance of Mr. Vignoles, the borough electrician, and his staff.

Electricity for Heating.—The town of Davos is considering a scheme for the abolition of all the ordinary forms of fuel. It is proposed to erect an extensive electric plant at the confluence of two large mountain torrents, whose united waters will supply the necessary motive power. The first cost of the installation is estimated to be 8½ million francs. Already electricity is used for lighting and motive power, and in many villas for cooking and heating, and in one of the largest bakeries. The idea is to do away with all contamination of the air by the use of fuel.

Appointments Vacant.—An electric meter-testing assistant for the Corporation of London, at £200; engineer-in-charge for Newport at £2; an outside superintendent for Ilford at £150. See "Official Notices" to-day.

The Manchester Municipal School of Technology.—There was a brilliant assembly at the opening of this Institution on Wednesday, by the Prime Minister, the Right Hon. A. J. Balfour. The Lord Mayor (Alderman Hay), who is chairman of the Technical Instruction Committee of the City Council, accompanied by the Town Clerk, waited upon Mr. Balfour at the Queen's Hotel shortly after 11 o'clock, and drove with him to the new building in Whitworth Street. Accommodation was provided for about 800 guests, who gave the Premier a very hearty reception. The right hon. gentleman opened the main door of the building with a gold key, which was presented to him by the Lord Mayor in the name of the Corporation.

Yorkshire College Engineering Society.—On Monday evening last Prof. John Goodman, M.I.C.E., delivered his presidential address and inaugural paper at Leeds on "Engineering in Canada and the United States."

Fire.—An electric organ at the East United Free Church, Aberdeen, has been destroyed by fire, fusion of wires being the alleged cause.

For Sale.—The Wakefield B. of G. offer a battery of 60 E.P.S. accumulators, and booster for charging same. See "Official Notices" to-day.

THE CENTRAL STATION ENGINEER.

Mr. R. Wheeler has resigned the position of mains superintendent under the Southport Corporation, and Mr. W. Green has been promoted by the Electricity Committee to the post, his salary being advanced from £130 to £143 per annum. Mr. W. Whitney has been appointed assistant mains inspector.

The Bristol Corporation Electricity Committee has appointed Mr. W. B. Morgan as mains engineer (in succession to Mr. Jenkins), at a salary of £156 per annum, and Mr. A. J. Crowther, of Leeds, as assistant mains engineer, at £130 a year.

Mr. R. N. Torpy has been appointed chief assistant engineer, and Mr. T. R. Stancombe, of Plymouth, engineer-in-charge, at Wimbledon electricity works.

Mr. A. C. Gilbert has been appointed assistant electrical engineer at Ilkeston by the T.C., at an annual salary of £110 per annum. There were 37 applicants.

Mr. A. E. Barker, station superintendent at East Ham Electricity Works, has resigned, and taken up the post of engineer to the Bexley District Council (a new undertaking which is in course of construction). Mr. W. R. Elliott (senior shift engineer) has been appointed station superintendent in place of Mr. Barker.

The electrical engineer at Heywood, Mr. W. S. Johnston, has resigned his position, having obtained a more lucrative appointment in the Midlands.

On Friday last, Mr. Gilbert R. Spurr, assistant engineer to the Ilford Urban District Council, was presented by the staff and employés with a marble clock, suitably inscribed, on the occasion of his marriage. Mr. Arthur H. Shaw, the resident electrical engineer, made the presentation.

Mr. J. S. Frain, who has had charge of the City of Durham works of the County of Durham Electrical Power Distribution Co., has been promoted to the head offices at Surrey House, London, and his place at Durham has been filled by Mr. W. H. Jay, from Gateshead. The company have obtained their order for the construction of the tramways from Durham to Brandon, and the work is being forwarded. It is hoped that the lines will be opened during the ensuing year.

Mr. Ralph Lomax, an assistant at the Darwen electricity works, has resigned his position, in order to take up duties as shift engineer at the Stockport electricity works.

NEW COMPANIES REGISTERED.

Rangoon Electric Construction Syndicate, Ltd. (75,041).—This company was registered on October 6th, with a capital of £1,000 in £1 shares, to apply for and obtain from the proper authority in Burmah concessions and powers for constructing and working electric tramways and electric lighting works, and to turn the same to account. The first subscribers (each with one share) are:—H. Howseman, 7, Queen's Gardens, W., solicitor; A. Jones, 54, Grantham Road, Stockwell, S.W., clerk; H. E. Brandt, 25, Cambridge Street, Eccleston Square, S.W., solicitor; F. C. Farrow, 7, Ossington Street, Bayswater, W., clerk; G. W. Farrow, 54, Lysias Road, Balham Hill, S.W., clerk; J. E. Waller, 29, Great George Street, S.W., civil engineer; and L. B. Aynlay, 269, High Road, Leyton, Essex, clerk. No initial public issue. The number of directors is not to be less than three nor more than five; M. F. Kindersley is one of the first; no qualification required.

D. Stewart & Co. (1902), Ltd. (5,192).—This company was registered in Edinburgh on October 8th, with a capital of £80,000 in £1 shares, to purchase the business, property and effects of D. Stewart & Co., Ltd. (now in liquidation), and to carry on the business of engineers, millrights, boiler makers, electricians, machinists, coppersmiths, founders, iron and steel manufacturers, makers of motors, motor cars, carriages, launches and vessels, shipowners, shippers, brokers and general merchants. The first subscribers (each with one share) are:—J. Beardmore, Parkhead Forge, Glasgow, engineer; D. Girdwood, Parkhead Forge, Glasgow, steel manufacturer; W. D. Beil, London Road Iron Works, Glasgow, engineer; D. McPhun, London Road Iron Works, Glasgow, secretary; A. M. Downie, London Road Iron Works, Glasgow, engineer; A. M. Mitchell, 160, W. George Street, Glasgow, writer; and J. B. Paterson, 160, W. George Street, Glasgow, writer. The number of directors is not to be less than two nor more than seven; the first are W. Beardmore and J. Beardmore; qualification, £1,000; remuneration as fixed by the company Registered office, London Road Iron Works, Glasgow.

Simpson Bros. (of Hapton), Ltd. (75,071).—This company was registered on October 9th, with a capital of £5,000 in £1 shares, to acquire and carry on the business of electrical and mechanical engineers carried on by W. FitzAllen Simpson at the Electrical Works, Hapton, and at Curzon Street, Burnley, Lancs., as "Simpson Bros.," and to carry on the business of manufacturing electricians, mechanical engineers, manufacturers of machines, articles and things used or required in the generation and utilisation of electricity or electrical energy, &c. The first subscribers (each with one share) are:—W. FitzAllen Simpson, Oakleigh, Hapton, near Burnley, electrical engineer; Mrs. I. Simpson, Oakleigh, Hapton, near Burnley; Miss I. Simpson, Oakleigh, Hapton, near Burnley; J. Hartley, 55, Victoria Buildings, Manchester, engineer; W. Hudson, 9, Curzon Street, Burney, book-keeper; J. F. Heap, 12, St. James's Row, Burnley, chartered accountant; and Mrs. M. Crook, Shuttleworth Hall, Hapton, near Burnley. No initial public issue. The first directors are W. FitzAllen Simpson and Mrs. I. Simpson; qualification, one share. Registered office, Electrical Works, Hapton, Lancs.

Electric Mercantile Agency, Ltd. (75,039).—This company was registered on October 6th, with a capital of £1,000 in £1 shares, to carry on the business of an electric light company, and of electricians, electrical, mechanical and general engineers, suppliers of electricity, manufacturers of electrical apparatus, &c. The first subscribers (each with one share) are:—J. D. Bancur, 5, Warwick Court, High Holborn, W.C., merchant; A. H. Dibley, 12, Cornfield Terrace, Eastbourne, typist; A. E. Barnard, 277, Lewisham High Road, S.E.; E. Hudson, 4, Ledbury Road, W., gentleman; H. Jewers, Birch House, Hayward's Heath, Sussex, director; W. Hudson, 38, Hornsey Park Road, Hornsey, N., clerk; and D. S. Anderson, 82, Summerhill Road, N., clerk. No initial public issue. The number of directors is not to be less than two nor more than five; the subscribers are to appoint the first; remuneration as fixed by the company.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Merthyr Electric Traction and Lighting Co., Ltd. (57,908).—This company's annual return was filed on July 26th, when 6,000 ordinary and 6,000 preference shares had been taken up out of a nominal capital of £100,000 divided into 10,000 ordinary and 10,000 preference shares of £5 each. £5 per share has been called up, resulting in the receipt of £60,000. Mortgages and charges, £30,000.

Electrical Oil Refining Co., Ltd. (43,126).—This company's annual return, made up to July 30th, has been filed. 4,375 shares have been taken up out of a nominal capital of £5,000 divided into 5,000 shares of £1 each. £1 per share has been called up on 882 shares, resulting in the receipt of £882. £3,493 is considered as paid on 3,493 shares. No mortgages or charges.

St. Helens Cable Co., Ltd. (62,471).—Issue on September 19th, 1902, of £5,000 second debs. (10 of £500 each), part of a series to secure a total sum unlimited in amount. Date of resolution authorising present issue: September 18th, 1902. Property charged: The company's undertaking and property, present and future, including uncalled capital. No trust deed. Persons entitled to the charge: W. W. Pilkington, St. Helens (£2,500), and J. Beecham, St. Helens (£2,500). Total amount previously issued of same series: £11,000.

Lymington Electric Light and Power Co., Ltd. (57,985).—A trust deed, dated September 26th, 1902, to secure £20,000 debentures, has been registered. Property charged: The land, buildings, machinery, works, plant, effects, undertaking and property of the company, present and future, including uncalled capital. Trustees: W. B. Hopkins, Clun House, Surrey Street, W.C.; and F. E. Gripper, Broad Sanctuary Chambers, Westminster, S.W.

Uxbridge and District Electric Supply Co. Ltd. (72,706).—Issued on September 30th of £1,000 debenture (10 of £100 each), part of a series created by resolution of directors dated July 18th, 1901, to secure a total sum of £9,000. Property charged: The company's undertaking and all its property, present and future, including uncalled capital. No trust deed. Total amount previously issued of same series, £12,500.

Walker & Hodgetts, Ltd. (67,312).—This company's annual return was filed on September 25th, when 500 preference and 2,000 ordinary shares were taken up out of a nominal capital of £5,000 in 2,000 preference and 3,000 ordinary shares of £1 each. £1 per share has been called up on 500 preference and 1,000 ordinary shares, resulting in the receipt of £1,500. 1,000 ordinary shares are considered as fully paid. No mortgages or charges.

CITY NOTES.

Cuba Submarine Telegraph Co.

The directors' report for the half-year ending June 30th, 1902, to be presented at the meeting on October 22nd, 1902, reads as follows:—

The total receipts for the six months were £14,082 16s. 4d., while the expenses amounted to £5,788 4s. 1d., leaving a balance of £8,894 12s. 3d., to which has to be added £4,590 6s. 4d. brought forward from last account, giving a total of £13,484 18s. 7d. to be dealt with. The sum of £2,752 7s. has been added to the reserve fund, which now stands at £129,000, after deducting £5,753 7s., the cost of the repairs to the Cape Cruz-Santiago cable. The dividend on the preference shares will absorb £3,000, and leave £7,732 11s. 7d., out of which the directors recommend the payment of a dividend at the rate of 4 per cent. per annum on the ordinary shares, free of income-tax; the balance, £4,582 11s. 7d., being carried forward to the current half-year. The cables have continued in good working order since the date of the last report. The directors regret that no reply has yet been received from the Government of the United States regarding the payment of the claim for damage done to the cables during the Spanish-American war. With regard to the claim for payment of the subsidy of £2,000 per annum in respect of the Coast cables, now in arrear since January, 1899, the company's representative at Havana has, in view of the establishment of the new Government in Cuba, been instructed to make the necessary application for payment in accordance with the company's concession. The appeal of the West India and Panama Telegraph Co. against the order of the Court of Appeal confirming the judgment of Mr. Justice Farwell, was heard by the House of Lords on June 20th and 23rd, and resulted in the appeal being dismissed with costs, thus terminating in this company's favour the litigation instituted in February, 1898, with respect to the construction of the agreement between the two companies dated January, 31st, 1870. The retiring director is Mr. Alexander G. Low, who, being eligible, offers himself for re-election. Messrs. Gane, Jackson, Jefferys & Wells, C.A., the auditors, also retire, and offer themselves for re-election.

New Issue.—The Windermere and District Electricity Supply Co., Ltd., has been making an issue of £20,000 4½ per cent. first mortgage debenture stock, of which £17,700 was offered at par. The list of subscriptions was to close on or before Thursday.

Indo-European Telegraph Co.—The directors have declared an interim dividend for the half-year ended June 30th at the rate of 5 per cent. per annum.

STOCKS AND SHARES.

Wednesday Evening.

With the coming of Autumn there should also arrive, according to all Stock Exchange tradition, an accession of business as a herald to the more active markets which are popularly supposed to be with us through the winter. So far the tradition shows no signs of being fulfilled this year, for the state of trade in the House is woefully slack, and the unanimity of opinion in all sections of the markets is as remarkable as the cause of it is regrettable. Great expectations were built upon the opening of Parliament some few weeks back, but even that event has lost its magnetism, and members of the Stock Exchange are at a loss to know in which direction to turn in the hopes of better times. Interest of electrical affairs, however, continues to expand, and while the Supply and the Telegraph sections complain of inaction, there is plenty to occupy the minds of those closely concerned with railway and other traction enterprises.

Central London Deferred, by its rise of a point, has overtaken the quotation for the company's Ordinary stock, which shows no change on the week. Sir Henry Oakley's spirited defence of the company's policy has even led to some hopes that the Central London may, after all, be permitted to accomplish its scheme of a circle. It may be suggested to the directors that while they deserve all praise for their perseverance in the wider aims, yet the condition of the existing line should also receive their continual attention. Despite the talk about new ventilation arrangements, the atmosphere of the Twopenny Tube seems to grow more vitiated every week. Central London stock has risen, but City and South London Ordinary shows a small decline, due to the apprehensions of what may be the outcome of the competition when the South of London tramways start work in good earnest. Important changes are taking place in the management of the London and South-Western, the parent of the Waterloo and City line. It is thought that the new comers will devote themselves seriously to the question of electric traction on the South-Western system, and Mr. Evelyn Cecil's appointment is especially hailed as the probable percursor to a radical change in the manner of haulage now adopted by the company. Since it is the South-Western Railway whose traffics are liable to be most severely cut into by the enterprise of the London United Tramways Co., stockholders in the former should be thankful to know that there is at least a prospect of the competition being met with energy and skill.

The Preference shares of the Tramways Co. have now improved to nearly 12, the partly-paid being 9, while the two Debentures are quoted at 108 and 82 for the fully and part-paid stocks respectively. Dealings are fairly active in British Electric Traction issues, and the Ordinary shares are ½ better. Brush shares, on the other hand, again display weakness, the unmarketability of the shares becoming still more pronounced. A general grumble goes up that of the four kinds of British Electric Traction now in circulation only one class enjoys that official quotation which gives an added value to the shares. So far as dividends go, all the Tractions now dealt in are equal, but the delay which has taken place as regards obtaining an official quotation places all but the one class at a disadvantage, and it is high time that those who are responsible for the matter should see it through the committee room of the Stock Exchange which deals with such affairs.

Electricity Supply shares show a single change, Westminster Ordinary having added 10s. to their quotation. Otherwise the list is colourless. The Edmundson Co. is seeking powers to issue fresh capital in the shape of both Ordinary and Preference shares, and there is no doubt that the increase will be duly sanctioned by the proprietors. A little business is afoot in the "City Undertaking" Preference shares of the Charing Cross and Strand, and the price is a shade under the par value of £5. A few City of London changed hands the other day at 10½, which is really an outside price, while Chelseas can be bought at a fraction within 5¾. Provincial shares have lapsed into quietude again, and there are no important alterations to record.

In the Telegraph division, a harder tone has come over the Anglo-American Co.'s stocks, notwithstanding the every-other-day weakness of the Yankee railroad market. Naturally, prices have thrown an unusual amount of business into the telegraph company's hands of late, and evidently some of the speculative investors are beginning to appreciate the fact. While the deferred stock of the Anglo-American Co. is unchanged at 7½, the two other issues both show rises of a point apiece, and whereas it was almost impossible to sell the Preferred at 92 a week or two back, the stock is now commanding 93 and upwards. Directs are about the same, and Submarine Cables Trust remains unaltered, but Globe Preference are again being sought by the cautious investor, and the shares are 5s. up. Commercial Cable Debenture stock has improved 1 per cent. In the Eastern group, the only recordable change is one of a small shrinkage in Eastern 4 per cent. Debenture stock.

Turning to the Miscellaneous Market, British Insulated Wire shares pursue the erratic tenor of their way by recovering the sharp fall which overtook them last week, but Crompton's have eased off again, and General Electric Debenture is a trifle easier. Telephone varieties are steady, but there is nothing doing in them.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. †	Dividends for the last three years. 1899.	1900.	1901.	Closing Quotations Oct. 8th.	Closing Quotations Oct. 15th.	Business done week ended Oct. 15th, 1902. Highest	Lowest.
67,100	African Direct Telegraph, 4 % Debs.					98 —102	98 —102		
25,000	Amazon Telegraph Co.'s shares, Nos. 1 to 25,000	10	..	..	..	3½— 4½	3½— 4½	..	..
119,700£	Do. do. 5 % Debs., Nos. 1 to 1,250 Red.	100	..	..	..	70 — 80	70 — 80	..	..
788,840	Anglo-American Telegraph	Stock	73/6	3½%	61s.	47 — 50	48 — 51	49½	..
3,105,580	Do. do. do. 6 % Pref.	Stock	6 %	6 %	6 %	91 — 93	92 — 94	93½	92
3,105,580	Do. do. do. Deferred	Stock	£1 7s.	5s. %	2s.	7½ — 7¾	7½ — 7¾	7¾	..
44,000	Chili Telephone, Nos. 1 to 44,000	5	4 %	5 %	5 %	3½ — 4	3½ — 4	4	..
13,333,300$	Commercial Cable	$100	8 %	8 %	8 %	160 —170 xd	160 —170	..	..
1,841,209	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	..	..	..	93 — 96 xd	94 — 96	95¼	95¼
16,000	Cuba Telegraph	10	7 %	4½%	4 %	5½— 6½	5½— 6½	..	..
6,000	Do. 10 % Pref.	10	..	..	..	13 — 14	13 — 14	..	..
12,931	Direct Spanish Telegraph	5	4 %	4 %	4 %	2½— 3½ xd	2½— 3½ xd	..	..
6,000	Do. do. 10 % Cum. Pref.	5	..	..	..	7 — 8 xd	7 — 8 xd	..	..
60,710£	Direct United States Cable	20	3½%	3½%	3½%	10½— 11	10½— 11	10½	..
96,300	Direct West India Cable, 4½% Reg. Deb., within Nos. 1 to 1,200, Red.	100	..	..	..	100 —103	100 —103	..	..
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	7 %	125 —130	125 —130	128½	125½
1,955,565	Do. 8½ % Pref. Stock	100	..	..	..	90 — 93	90 — 93	92½	91
1,534,645	Do. 4 % Mort. Deb. Stock Red.	Stock	..	..	..	107 —110	106 —109	..	..
800,000	Eastern Extension, Australasia, and China Telegraph	10	7 %	7 %	7 %	12 — 12½	12 — 12½	12⅝	12 5/16
320,000£	Do. 4 % Deb. Stock	Stock	..	..	..	107 —110	107 —110	107	..
300,000	Eastern & South African Tele., 4% Mt. Db., Nos. 1 to 3,000, red. 1909	100	5¼%	..	..	99 —102	99 —102	..	..
200,000£	Do. do. 4 % Reg. Mort. Debs. (Mauritius Sub.) 1 to 8,000	25	..	..	..	101 —104 %	101 —104 %	..	..
180,227	Globe Telegraph and Trust	10	5½%	5½%	5½%	9½— 10	9½— 10	9⅝	9⅜
180,042	Do. do. 6 % Pref.	10	..	..	..	13½— 13⅝	13½— 14	13⅝	13 7/8
150,000	Great Northern Telegraph, of Copenhagen	10	12½%	15 %	15 %	27 — 28	27 — 28	..	..
70,000	Halifax and Bermudas Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	..	..	..	100 —103	100 —103	..	..
17,000	Indo-European Telegraph	25	10 %	10 %	10 %	38 — 42	38 — 42	41½	..
100,000£	London Platino-Brazilian Telegraph, 6 % Debs.	100	..	..	..	101 —105	101 —105	..	..
72,680	Montevideo Telephone, Ltd., Ord. Nos. 1 to 72,680	1	2½%	..	..	½— ¾	½— ¾	..	..
86,492	Do. do. 5 % Pref., Nos. 1 to 86,492	1	5 %	..	..	½— 1	½— 1	..	..
1,983,333	National Telephone, Pref. Stock	100	5 %	5 %	5 %	93 — 95	93 — 95	94½	93½
1,966,667	Do. do. Def. Stock	100	..	60	64 xd	55 — 57	55 — 57	..	..
15,000	Do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	12½— 13½	12½— 13½	..	..
15,000	Do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	11½— 12½	11½— 12½	..	..
250,000	Do. do. 5 % Non-cum. 3rd. Pref., 1 to 250,000	5	5 %	5 %	5 %	4½— 5⅛	4½— 5⅛	5	..
2,000,000£	Do. do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	96 — 99	96 — 99	97½	..
600,000	Do. do. 4 % Deb. Stock Red.	100	..	4 %	4 %	102 —106	102 —106	..	..
171,504	Oriental Telephone and Elec. Nos. 1 to 171,504, fully paid	1	5 %	6 %	6 %	½— 1	½— 1	..	..
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000	100	..	..	..	99 —102	99 —102	..	..
11,889	Reuter's	8	5 %	5 %	5 %	6½— 7½	6½— 7½	..	..
3,308	Submarine Cables Trust	Cert.	..	..	..	110 —120	110 —120	..	..
58,000	United River Plate Telephone	5	7 %	7 %	7 %	4½— 5¼	4½— 5¼	..	..
40,000	Do. do. 5 % Cum. Pref., Nos. 1 to 40,000	5	..	..	..	4½— 5	4½— 5	..	..
179,947£	Do. do. 5 % Debs.	Stock	..	..	..	102 —105	102 —105	..	..
15,609	West African Telegraph, Shares	10	..	..	..	3½— 4½	3½— 4½	..	..
30,008	West Coast of America, Nos. 1 to 30,000 and 53,001 to 53,008	2½	..	..	..	½— ⅝	½— ⅝	..	..
150,000£	Do. do. 4% Debs., 1 to 1,500 guar. by Braz. Sub. Tel.	100	..	..	..	98 —101	98 —101	98	..
267,980	Western Telegraph, Ltd., Nos. 1 to 207,980	10	7 %	7 %	7 %	11½— 12½	11½— 12½	12½	11⅞
75,000£	Do. do. 5 % Debs. 2nd series, 1906	100	..	..	..	102 —105	102 —105	..	..
400,000	Do. do. 4 % Deb. Stock Red.	100	..	..	..	99 —102	99 —102	..	..
88,321	West India and Panama Telegraph	10	5%	1%	..	½— ¾	½— ¾	..	..
84,563	Do. do. do. 6 % Cum. 1st Pref.	10	..	..	..	4½— 5	4½— 5	..	..
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	..	..	..	3 — 4	3 — 4	..	..
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	..	..	..	99 —102	100 —103	..	..

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.

20,000	British Aluminium 7 % Cum. Pref.	10	..	5½%	..	3½— 4½	3½— 4½	..	..
800,000£	Do. do. 5 % 1st Mort. Deb. Stock Red.	Stock	..	..	..	83 — 88	83 — 88	..	..
100,000	British Electric Traction	10	8 %	9 %	9 %	12½— 13¼	13 — 14	13½	13¼
100,000	Do. do. 6 % Cum. Pref.	10	..	..	..	12½— 13	12½— 13	13½	12 9/16
600,000£	Do. do. 5 % Perpetual Debenture Stock	Stock	..	..	..	124 —127	124 —127	126	124½
100,000	British Insulated Wire Ord.	5	20 %	15 %	10 %	7½— 7¾	7¾— 8½	8⅛	..
100,000	Do. do. 6 % Cum. Pref.	5	..	..	..	5¾— 6	5¾— 6	..	..
50,000	Do. do. 4½ % 1st Mort. Deb. Red.	100	..	..	..	102 —105	103 —106	..	..
50,000	¶Browett, Lindley & Co. (1899), Ord.	£1	..	8 %	..	13s. to 15s.	13s. to 15s.	..	..
50,000	¶ Do. do. 6 % Cum. Pref.	£1	..	6 %	..	16s. to 16/6	16s. to 16/6	..	..
105,731	Brush Electrical Engineering, Ord., 1 to 105,731	2	5½%	5 %	Nil	1 — 1¼	¾— 1¼	..	..
150,000	Do. do. Non-cum. 6 % Pref.	2	6 %	6 %	3 %	1¼— 1¾	1 — 1¼	1¼	..
125,000£	Do. do. 4½ % Perp. Deb. Stock	Stock	..	..	..	100 —103	100 —103	..	..
125,000£	Do. do. 4½ % Perp. 2nd Deb. Stock	Stock	..	..	..	93 — 96	94 — 99	..	..
35,000	Callender's Cable Construction shares	5	15 %	15 %	20 %	15½— 16½	15½— 16½	16⅛	16
40,000	Do. do. do. 5 % Cum. Pref.	5	..	..	..	5½— 6½	5½— 6½	..	..
90,000£	Do. do. do. 4½ % 1st Mort. Deb. Stock Red.	Stock	..	..	..	109 —113	109 —113	..	..
1,960,014	Central London Railway, Ord. Stock	Stock	..	..	4 %	104 —107	104 —107	107	105¾
494,098	Do. do. 4 % Pref. Stock	Stock	..	..	4 %	107 —110	107 —110	108¾	108
494,998	Do. do. Def. do.	Stock	..	..	4 %	104 —107	105 —108	106	..
1,330,000	City and South London Railway	Stock	1½%	1½%	2 %	72 — 74	71 — 73	72½	71½
85,000	Crompton & Co., Nos. 1 to 85,000	3	7½%	8 %	7½%	2½— 3	2½— 2¾	2½	..
100,000£	Do. 5 % 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 red.	..	..	..	..	101 —106 %	101 —106 %	..	..
99,261	Edison & Swan United Elec. Light, "A" shares, £3 paid, 1 to 99,261	5	6 %	2½%	..	¼— ⅜	¼— ⅜	..	..
17,189	Do. do. "A" shares, 01—017,189	5	6 %	2½%	..	1½— 2¼	1½— 2¼	..	..
344,922£	Do. do. 4 % Deb. Stock Red.	100	..	..	..	74 — 78	74 — 78	..	..
100,000£	Do. do. 5 % 2nd Deb. Stock Prov. Certs. all pd.	100	..	..	..	77 — 82 xd	77 — 82	..	..
112,100	Electric Construction, 1 to 112,100	3	6 %	6 %	6 %	1½— 2	1½— 2	..	..
31,350	Do. do. 7 % Cum. Pref., 1 to 31,350	3	..	..	..	2½— 3	2½— 3	..	..
182,500£	Do. do. 4 % Perp. 1st Mort. Deb. Stock	Stock	..	..	..	99 —102	99 —102	100	..
25,000	General Electric Co. (1900), 5 % Cum. Pref.	10	..	5 %	5 %	10 — 10½	10 — 10½	..	..
200,000	Do. do. 4 % Mort. Deb.	Stock	..	..	..	100 —103	99 —102	101	..
35,000	Henley's (W. T.) Telegraph Works, Ord.	5	15 %	20 %	20 %	16 — 17	16 — 17	16⅜	..
35,000	Do. do. 4½ % Pref.	5	4½%	4½%	..	5¼— 5⅝	5¼— 5⅝	..	..
48,050	Do. do. 4½ Mort. Deb. Stock	Stock	..	..	..	109 —113	109 —113	..	..
50,000	India-Rubber, Gutta-Percha & Telegraph Works	10	10 %	10 %	..	20½— 21¼	20½— 21½	..	..
300,000£	Do. do. do. 4 % 1st Mort. Deb.	100	..	..	..	99 —102	99 —102	..	..
37,500	‡Liverpool Overhead Railway, Ord.	10	3½%	3½%	1½%	4½— 4⅝	4½— 5	..	..
10,000	‡ Do. do. Pref. £10 paid	10	5 %	..	..	9½— 10½	10 — 10½	..	..
7,500	Parker (Thomas), Ltd., Ord., Nos. 1 to 7,500	10	..	..	..	14½— 15½	14½— 15½	..	..
	§Rosling & Fynn 6 % Cum. Pref.	£1	..	6 %	..	— —	19/0 to 20/0	..	..
37,350	Telegraph Construction and Maintenance	12	15 %	17½%	20 %	38 — 41	38 — 41	38½	38
150,000£	Do. do. 4 % Deb. Bds., Nos. 1 to 1,500 Red. 1909	100	..	..	..	102 —105	102 —105	..	..
540,000£	Waterloo & City Railway, Ord. Stock	100	3 %	3 %	3 %	90 — 93	90 — 93	..	..

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid.
§ From Bradford Share List. ¶ From Manchester Share List.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Consolidated Telephone Construction and Maintenance, ⅛—⅜.
National Electric Free Wiring, ½—1.
Oldham, Ashton, and Hyde Electric (£10 pd.), Ord., 13—14.
Do. do. Pref. (£10 pd.), 10—11.

Bank rate of discount 4 per cent. (October 2nd, 1902).

SHARE LIST OF ELECTRICAL COMPANIES (*continued*).—ELECTRICITY SUPPLY COMPANIES.

Present issue.	NAME.	Stock or Share.	Dividends for the last three years. 1899.	1900.	1901.	Closing Quotations Oct. 8th.	Closing Quotations Oct. 15th.	Business done week ended Oct. 15th, 1902. Highest.	Lowest.
100,000	Blackheath and Greenwich Dist. Electric Light, Ord.	‡ 1	..	..	..	3/8 — 5/8	3/8 — 5/8	..	..
100,000	Do. 4½% 1st Deb. Stock, Prov. Certs.	100	..	..	..	104 —107 xd	105 —108	..	..
20,000	Brompton & Kensington Electric Light Sup., Ord., 1 to 20,000	5	6 %	6 %	8 %	10 — 10⅜	10⅛ — 10⅜	10½	..
20,000	Do. do. 7 % Cum. Pref.	5	..	..	..	10⅛ — 10⅜	10⅛ — 10⅜	..	..
50,000	Charing Cross and Strand Electricity Supply	5	9 %	9 %	10 %	9 — 9⅛	9 — 9⅛	9 5/8	..
70,080	Do. do. do. 4½% Cum. Pref.	5	..	..	..	5⅛ — 6	5⅛ — 6	..	..
40,000	Do. do. "City Undertaking" 4½% Cum. Pref.	5	..	..	..	4⅞ — 5⅛	4⅞ — 5⅛	4 13/16	4⅞
250,000	Do. do. 4 % Deb. Stock Red.	100	..	..	..	105 —107	105 —107	106⅛	106⅛
44,436	*Chelsea Electricity Supply, Ord.	5	6 %	5⅓%	4 %	5⅛ — 6	5⅛ — 6	5 1/16	5 1/16
150,000	Do. do. % Deb. Stock Red.	Stock	..	..	..	109 —112	109 —112	..	..
70,595	City of London Electric Lighting, Ord. 40,001—110,595	10	4 %	0 %	5 %	9⅛ — 10⅛	9⅛ — 10⅛	10⅛	..
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	..	12⅛ — 13⅛	12⅛ — 13⅛	..	..
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at 115) all paid	..	..	..	..	123 —128	123 —128	..	..
300,000	Do. 4½% 2nd Deb. Stock, Prov. Certs., all paid	100	..	..	..	103 —106	103 —106	..	..
40,000	County of London & Brush Prov. Electric Lighting, Ord. 1—40,000	10	4 %	4 %	4 %	8⅛ — 9⅛	8⅛ — 9⅛	..	..
20,000	Do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	..	11⅛ — 12⅛	11⅛ — 12⅛	..	..
400,000	Do. do. 4½% Deb. Stock, Prov. Certs. (all paid) Red	..	..	..	..	111 —114	111 —114	..	..
50,000	Edmundson's Electric Corporation, Ord. Shares	5	6 %	7 %	7 %	6⅛ — 6⅞	6⅛ — 6⅞	6⅜	6⅞
30,000	Do. do. 6 % Cum. Pref.	..	..	..	..	6 — 6⅛	6 — 6⅛	6⅛	6 1/16
140,000	Do. do. 4½% 1st Mort. Deb. Stock	100	..	..	..	107 —110	107 —110	108⅛	..
21,000	Kensington and Knightsbridge Electric, Ord.	5	11 %	12 %	10 %	10 — 11	10 — 11	10 1/16	..
90,000	Do. do. do. 4 % Debenture Stock	Stock	..	..	..	101 —104	101 —104	..	..
110,000	London Electric Supply Corporation, Limited, Ord.	3	..	..	..	1⅞ — 2⅛	1⅞ — 2⅛	..	..
49,840	Do. do. 6 % Pref.	5	..	..	..	4⅛ — 5	4⅛ — 5	4 1/16	..
250,000	Do. do. do. 4 % 1st Mort. Deb. Stock Red	Stock	..	..	..	96 — 99	96 — 99	..	..
100,000	Metropolitan Electric Supply, 1 to 100,000	10	5 %	6 %	6½%	15⅛ — 16⅛	15⅛ — 16⅛	..	..
220,000	Do. do. 4½% 1st Mort. Deb. Stock	..	..	..	..	110 —115	110 —115	..	..
250,000	Do. do. 3½% Mort. Deb. Stock Red	Stock	..	..	..	99 —102	99 —102	..	..
10,852	Notting Hill Electric Lighting	10	7 %	7 %	6 %	13⅛ — 14⅛	13⅛ — 14⅛	..	..
40,000	St. James' and Pall Mall Electric Light, Ord.	5	14½%	14½%	14½%	15 — 16	15 — 16	..	..
20,000	Do. do. do. 7 % Pref. 20,001 to 40,000	5	7 %	7 %	7 %	8⅛ — 9⅛	8⅛ — 9⅛	..	..
150,000	Do. do. do. 3½% Deb. Stock Red	100	..	..	..	98 —101	98 —101	..	..
12,000	Smithfield Markets Electric Supply, Ord.	5	..	..	..	1⅞ — 2⅛	1⅞ — 2⅛	..	..
50,000	Do. do. 4% Deb.	100	..	..	..	80 — 90	80 — 90	..	..
65,000	South London Electricity Supply, Ord.	5	..	..	..	2⅛ — 3	2⅛ — 3	2 1/16	2⅛
110,000	Westminster Electric Supply, Ord.	5	13 %	10½%	10½%	11 — 12	11⅛ — 12⅛	12⅛	11⅛
28,141	Do. do. 5 % Cum. Pref.	5	..	..	..	6 — 6⅛	6 — 6⅛	..	..

* Subject to Founders Shares. ‡ Unless otherwise stated all shares are fully paid.

MARKET QUOTATIONS, Wednesday, October 15th.

CHEMICALS, &c.		This week.	Last week.	Inc. or Dec.
a Acid, Hydrochloric	per cwt.	5/-	5/-	..
a ,, Nitric	per cwt.	22/-	22/-	..
a ,, Oxalic	per cwt.	32/-	32/-	..
a ,, Sulphuric	per cwt.	5/6	5/6	..
a Ammoniac, Sal	per cwt.	42/-	42/-	..
a Ammonia, Muriate (crystal)	per ton	£33 10	£33 10	..
a ,, ,,	per ton	£30	£30	..
a Bleaching powder	per ton	£4 10	£4 10	..
a Bisulphide of Carbon	per ton	£15	£15	..
a Borax	per ton	£13	£13	..
a Bensole (90 %)	per gal.	7/-	7/-	..
a ,, (50/90 %)	per gal.	5/6	5/6	..
a Copper Sulphate	per ton	£19	£19	..
a Lead, Nitrate	per ton	£24	£24	..
a ,, White Sugar	per ton	£31	£31	..
a ,, Peroxide	per ton	£27 10	£27 10	..
a Methylated Spirit	per gal.	2/6	2/6	..
a Naphtha, Solvent (90% at 160° C).	per gal.	5/6	5/6	..
a Potash, Bichromate, in casks	per lb.	3½.	3½.	..
a ,, Caustic (75/80%)	per ton	£24	£24	..
a ,, Bisulphate	per ton	£35	£35	..
a Shellac	per cwt.	109/-	109/-	..
a Sulphate of Magnesia	per ton	£4 10	£4 10	..
a Sulphur, Sublimed Flowers	per ton	£6 5	£6 5	..
a ,, Recovered	per ton	£5 10	£5 10	..
a ,, Lump	per ton	£5	£5	..
a Soda, Caustic (white 70 %)	per ton	£10 15	£10 15	..
a ,, Crystals	per ton	£3	£3	..
a ,, Bichromate, casks	per lb.	2¼d.	2¼d.	..
METALS, &c.				
b Aluminium Ingots, in ton lots	per ton	£148	£148	..
b ,, Wire, in ton lots	per ton	£224	£224	..
b ,, Sheet, in ton lots	per ton	£191	£191	..
p Babbitt's metal ingots	per ton	£40 to £140	£40 to £140	..
c Brass (rolled metal 2" to 12") basis	per lb.	6¾d.	6¾d.	..
c ,, Tube (brazed)	per lb.	8¼d.	8¼d.	..
c ,, ,, (solid drawn)	per lb.	7d.	7d.	..
c ,, Wire, basis	per lb.	7d.	7d.	..
c Copper Tubes (brazed)	per lb.	8¾d.	8¾d.	..
c ,, ,, (solid drawn)	per lb.	9d.	9d.	..
g Copper Bars (best selected	per ton	£67	£69	£2 dec.

METALS, &c. (*continued*).		This week.	Last week.	Inc. or Dec.
g Copper Sheet	per ton	£67	£69	£2 dec.
g ,, Rod	per ton	£67	£69	£2 dec.
e ,, (Electrolytic) Bars	per ton	£65	£67	£2 dec.
e ,, ,, Sheets	per ton	£74	£74	..
e ,, ,, Rod	per ton	£65	£67	£2 dec.
e ,, ,, H.C. Wire	per lb.	7¼d.	7¼d.	¼d. dec.
f Ebonite Rod	per lb.	3/-	3/-	..
f ,, Sheet	per lb.	5/-	5/-	..
n German Silver Wire	per lb.	1/4½	1/5	½d. dec.
h Gutta-percha fine	per lb.	8/-	8/-	..
h India-rubber, Para fine	per lb.	3/1 to 3/2½	3/1½ to 3/3	½d. dec.
i Iron, Charcoal Sheets	per ton	£18	£18	..
i ,, Pig (Cleveland warrants)	per ton	53/5½	53/6	½d. dec.
i ,, Forgings, according to size	per ton	From £11	From £11	..
i ,, Scrap, heavy	per ton	47/6 to 50/-	47/6 to 50/-	..
i ,, Wire, galvanised No. 8	per ton	£9 15	£9 15	..
g Lead, English Ingot	per ton	£11 to £11 2 6	£10 15 to £11	inc.
g ,, ,, Sheet	per ton	£13	£13	..
m Manganin Wire No. 28	per lb.	8/-	8/-	..
g Mercury	per bot.	£8 15	£8 15	..
d Mica (in original cases) small	per lb.	3d. to 9d.	3d. to 9d.	..
d ,, ,, ,, medium	per lb.	1/9 to 2/9	1/9 to 2/9	..
d ,, ,, ,, large	per lb.	3/3 to 7/3	3/3 to 7/3	..
p Phosphor Bronze, plain castings	per lb.	11½d. to 1/2	11½d. to 1/2	..
p ,, rolled bars & rods	per lb.	1/- to 1/3	1/- to 1/3	..
p ,, ,, strip & sheet	per lb.	From 1/2	From 1/2	..
o Platinum	per oz.	£4	£4	..
p Silicium Bronze Wire	per lb.	9d. to 1/-	9d. to 1/-	..
i Stee, Magnet, acc'd'g to desc'p'n	per ton	£58	£58	..
i ,, ,, in bars		From £15	to £40	..
g Tin, Block	per ton	£ 117 10 to £118 10	£116 to £117	£1 10 inc.
g ,, Foil	per lb.	1/6	1/6	..
n ,, Wire, Nos. 1 to 16	per lb.	1/6½	1/6½	..
p White Anti-friction Metals—				
"White Ant" brand	per ton	£36 to £60	£36 to £60	..
j Yarns, 2/10s Grey Cotton, on sp'ls	per lb.	7d.	7d.	..
j ,, 6 lea. Flax	per lb.	5½l.	5½l.	..
j ,, 3 ply 10 lbs. Russian	per lb.	4½d.	5½d.	..
j ,, 10 lbs. Russian, single	per lb.	4½d.	4½d.	..
j ,, 180 lbs. Jute rove	per ton	£11 15	£ 1 11	..
k Zinc, Sh't (Vieille Montagne bnd.)	per ton	£23	£23	..

Quotations supplied by { *a* Messrs. G. Boor & Co. *b* The British Aluminium Co., Ltd. *c* Messrs. Thos. Bolton & Sons., Ltd. *d* Messrs. F. Wiggins & Sons. *e* Messrs. Frederick Smith & Co.

Quotations supplied by { *f* India-Rubber, G.P. and Teleg. Works *g* Messrs. James & Shakespeare. [Co., Ltd. *h* Messrs. Edward Till & Co. *i* Messrs. Bolling & Lowe. *j* Messrs. Walter H. Hindley & Co., Ltd.

Quotations supplied by { *k* Messrs. Morris Ashby, Limited. *m* Messrs. W. T. Glover & Co., Ltd. *n* Messrs. P. Ormiston & Sons. *o* Messrs. Johnson, Matthey & Co., Ltd. *p* The Phosphor Bronze Company, Ltd.

TRAFFIC RECEIPTS.

Company.	Week ending	Receipts for the week. Am'nt.	Inc. or dec.*	Total to date. Am'nt.	Inc. or dec.*	Miles open. This year.	Last year.
		£	£	£	£		
Blackburn Corp. Trys.	Sept. 26	231	+ 58	22,665	+ 3,797	12½	12½
Blackpool and Fleetwood	Oct. 11	457	+129	18,555	— 314	7½	7½
Bristol Trys. & Car. Co.	,, 10	4,541	+691	—	—	28	28
British Elec. Trac. Co.:—							
Devonport	,, 3	400	+ 48	17,271	+ 716	5	5
Dudley—Stourbridge	,, 3	789	+ 58	30,043	+ 3,759	18½	18½
Gateshead—Northfleet	,, 3	869	+206	29,525	+ 5,802	10½	9½
Gravesend	,, 3	196	—	1,992	—	9½	—
Greenock—Pt. Glasgow	,, 3	686	+426	20,158	+12,204	7½	7½
Harlepool	,, 3	22	— 34	10,298	+ 1,144	6½	4½
Kidderminster	,, 3	130	— 5	5,015	+ 21	4½	4½
Merthyr	,, 3	198	— 64	8,079	— 1,486	3	3
Middleton	,, 3	268	—	8,622	—	8½	—
Oldham—Ashton	,, 3	569	+ 39	21,166	+ 1,051	8	8
Poole	,, 3	260	— 14	10,500	— 134	8½	8½
Potteries	,, 3	1,089	+159	48,441	+ 2,516	28½	28½
Rothesay	,, 3	179	+120	1,468	+ 448	—	—
B.E.T. Co. (*continued*)—							
Southport	Oct. 3	281	+ 91	10,454	+ 3,688	5½	5½
South Staffordshire	,, 3	762	—132	30,310	— 727	21½	22½
Swansea	,, 3	497	+ 25	18,980	+ 1,227	6½	5½
Taunton	,, 3	59	— 33	2 666	— 262	1½	—
Tynemouth	,, 3	223	+ 61	12,124	+ 1,498	9½	8½
Weston-super-Mare	,, 1	125	—	5,167	—	3½	—
Wolverhampton Dist.	,, 3	335	+208	7,968	+ 5,194	10½	2½
Central London Railway	,, 11	6,858	+567	95,696	+ 8,261	6	6
City and S. London Ry.	,, 12	3,940	+1,268	42,636	+14,325	6½	4½
Doncaster Corp. Trys.	Sept. 27	—	—	1,546	—	5½	—
Dover Corporation Trys.	Oct. 11	214	— 9	9,207	+ 71	3	3
Dublin United Trys.	,, 10	4,525	— 98	74,888	+ 662	46	46
East Ham Tramways	,, 4	485	+ 60	—	—	5	4½
Glasgow Corp. Trys.	,, 11	13,403	—854	231,496	—10,679	57½	49
Liverpool Overhead Ry.	,, 12	1,470	+ 45	28,780	— 1,205	6½	6½
Newcastle Corp. Trys.	,, 11	3,015	—	—	—	35	—
Sunderland Corp. Trys.	,, 12	1,112	+ 90	—	—	17½	17½

* Compared with the corresponding period of 1901.

DATA OF PRINCIPAL POWER STATIONS IN GREATER NEW YORK.

At a recent meeting of the Association of Edison Illuminating Companies, Mr. W. F. Wells presented a paper in which was given a comparison of the five principal power stations of recent construction in Greater New York, as follows:—

Station of Metropolitan Street Railway Co., at Ninety-sixth Street and East River; Manhattan Railway Co., at Seventy-fifth Street and East River; Metropolitan Street Railroad Co., at 216th Street and Harlem River (Kingsbridge); Rapid Transit Subway Co., at Fifty-eighth Street and North River, and the Waterside Station of the New York Edison Co., at Thirty-eighth Street and East River. Below are given the principal data of the compilation, which we abstract from the *Electrical World and Engineer*.

	Metropolitan.	Manhattan.	Kingsbridge.	Rapid Transit.	Edison.
Ground area buildings, sq. ft.	48,800	79,064	39,360	116,000	58,819
Floors	3	2	2	1	2
Total area boiler rooms, sq. ft.	63,495	85,000	34 560	46,980	43,826
Total area engine rooms, sq. ft.	24,420	35,340	20,960	69,020	32,155
Total rated generator kw. capacity.	38,500	40,000	28,000	50,000	56,000
Total max. generator kw. capacity.	51,700	60,000	—	75,000	80,000
Number chimneys	1	4	2	5	4
Height above lower grades	353′	278′	200′	325′	196′
Internal diameter	22′	17′	14′	15′	17′
Total area, all stacks, sq. ft.	380	908	308	880	908
Ratio, grate surface to stack area.	12·3	8·1	11·2	?	7·3
Capacity, bunker (tons)	9,000	15,000	6,000	15,000	10,000
Number of boilers	57	64	30	60	56
Rated H.P. each	265—350	520	530	650	650
Rated H.P. agg. basis 10. sq. ft. h.s. per H.P.	25,520	33,280	15,600	39,000	36,400
Ratio, boiler to eng. H.P. (nor. rating).	0·51	0·51	0·436	0·49	0·44
Heating surface aggregate. sq. ft.	255,200	335,*70	153,600	390,000	364,000
Grate area, total	4,669	7,360	3,450	?	5,684
Ratio, heating to grate surface	51—61·4	45·2	45·2	?	56·6—74
Ash-pit pressure	—	1·7″	3″	—	3″
Total heating surface economisers.	—	98,334	57,600	124,800	—
Number of engines	11	8	8	10	16
Height, floor to top of cylinder	34′ 9″	38′ 4″	35′	35′	37′ 3″
Floor space	28′×42′	2,000 sq. ft.	28′×38′	40′×87′ 6″, 1,500 sq. ft.	41′×23′, 913 sq. ft.
Type	Vert. cross comp.	D'ble comp. 2 hor. cyl. 2 vert. cyl.	Vert. cross comp.	D'ble comp. 2 hor. cyl. 2 vert. cyl.	3 cyl. vert. comp.
H.P. each, nominal	4,500	8,000	4,500	8,000	5,200
H.P. each, maximum	6,000	12,500	6,250	12,000	8,000
H.P. total, nominal	49.500	64,000	36,000	80,000	83,200
H.P. total, maximum	66,000	100 000	50,000	125,000	128,000
Cylinders	46″-80″	(2) 44″-(2) 85″	46″-80″	(2) 42″-(2) 85″	48½″-(2) 75½″
Steam pressure	160	160	150	175-200	175
Cylinder ratio	3·5 : 1	4 : 1	3·5 : 1	4·2 : 1	6·03 : 1
Cranks	2	2	2	2	3
Piston rods, diameter	9″-10″	8″	9″-10″	8″ H.P., 10″ L.P.	9″
Connecting rods, length in ft.	12′ 6″	13′ 6′	12′ 6″	13′ 6′	13′ 9′
Length referred to crank	5	5·4	5	5·4	5·5
Crank pins	14×14	18×18	14×14	20×13	Centre 22×14, overhung 16×14
Wrist pins	14×14	12×12	14×14	12×12	14×14
Shaft—length	27′ 4″	25′ 8″	27′	25′ 8″	35′
Shaft—maximum diameter	37″	37″	39″	37″	29″
Shaft—diameter hole	16″	16″	16″	16″	10″
Bearings	34″×60″	34″×60″	34″×60″	34″×60″	26″×60″
Total weight on bearings	500,000 lbs	439,000 lbs.	507,000 lbs	439,000 lbs.	483,755 lbs.
Fly-wheel—diameter	28′	none	28′	none	24′
Fly-wheel—weight, tons	100	none	100	none	72
Weight of alt. field, tons	65	116	—	116	65
Kind of condensers	Surface	Jet	Jet	Barometric tube (jet)	Surface
Number of generators, 3-phase	11	8	8	10	16
kw. capacity, rated each	3,500	5,000	3,500	5,000	3,500
kw. capacity, overload	4,700	7,500	—	7,500	5,000
Volts	6,600	11,000	6,600	11,000	6,600
Diameter revolving field	16′ 5″	8′	—	8′	16′ 5″
Weight revolving field, lbs.	180.000	370,000	120,000	370,000	180,000
Weight of armature	180,000	520,000	158,500	520,000	125,000
Circumferential speed per minute.	8,927	7,540	—	7,540	8,927
Diameter frame	21′ 6″	43′	25′ 9″	43′	23′ 9″
Total weight, lbs.	260,000	890,000	—	890,000	755,000
Frame divided into segments	2	6	2	7	2
Inherent regulation	5%	6%	—	6%	8%
Guaranteed effic ency, ¼ load	90·8%	90%	—	—	91%
Guaranteed efficiency, ½ load	94·8%	94·5%	—	—	95%
Guaranteed efficiency, ¾ load	94·2%	95·5%	—	—	96%
Guaranteed efficiency, full load	96·1%	96·5%	—	—	97%
Guaranteed efficiency, 1¼ load	97%	97%	—	—	97%
Actual efficiency, ¼ load	—	93·15%	—	—	93·2%
Actual efficiency, ½ load	—	96·20%	—	—	96·5%
Actual efficiency, ¾ load	—	97·20%	—	—	96·5%
Actual efficiency, full load	—	97·75%	—	—	97·0%
Actual efficiency, 1¼ load	—	97·98%	—	—	97·2%
Guar. temp. rise, full load, 24 hours.	—	35° C.	—	—	30° C.
Insulation test armature coils	—	25,000 V. 30 M.	—	25,000 V. 30 M.	15,000 V. 30 M. 25,000 V. 1 M.
Armature winding	Form wound.	Built up, or bar type.	Built up, or bar type.	Built up, or bar type.	Form wound.
Number of exciters	6	4	5	4	8
Capacity exciter generator	150 kw.	250 kw.	160 kw.	250 kw.	150 kw.
Voltage	125	250 volts	125	250	300
Amperes per field normal load	900	225	—	225	120
Volts across field terminals	100	240	—	200	176
Approximate floor space, sq. ft.	6,400	12,000	—	—	10,000
Number feeders, present	—	34	—	86	28
Number feeders, ultimate	80	48	—	64	40

Details common to all:—Armatures star connected, revolutions per minute, 75; number of magnet poles, 40; frequency, 25 cycles per second; stroke of engines, 60 in.; piston speed, 750 ft. per minute.

DR. MUIRHEAD'S NEW MODE OF TRANSMISSION AND RELAY FOR CABLES.

By JOHN MUNRO.

(*Concluded from page* 642.)

It may appear useless to make the relay divide or split up the prolonged signals on repeating them into the second cable, which, in its turn, will only reunite them as before. If such a division is required, however, Dr. Muirhead employs the arrangement shown in fig. 13, where c_1 is the first and c_2 the second cable, which are

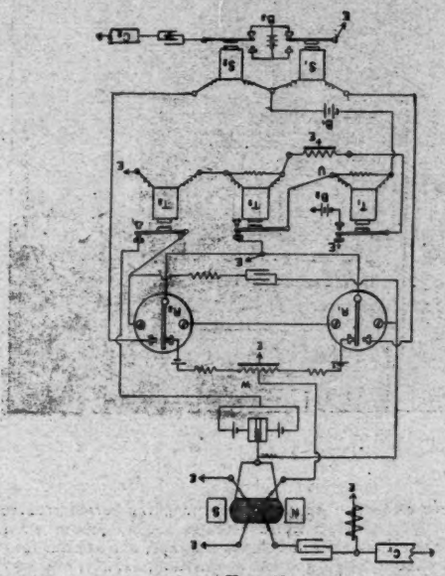


Fig. 13.

joined through the vibrating plate relay N S, two Post Office relays B_1 B_2, three electro-magnets or sounders T_1 T_2 T_3, and s_1 s_2 the coils of a cable transmitter.

The coil of the first sounder T_1 is connected between the junction of the two coils s_1 s_2 of the cable transmitter, and the two contact tongues of the Post Office relays B_1 B_2, through the armature and upper limiting stop of the second sounder T_2, and the battery B_1, which works s_1 s_2, the cable transmitter.

The coil of the second sounder T_2 and another battery B_2 are connected to the armature and the lower limiting stop of the first sounder T_1, so that the circuit is closed when the armature is attracted down on the lower limiting stop. In circuit with T_1 is also a retardation U, composed of Muirhead's artificial line, or an equivalent of inductance and resistance.

The sounders T_1 T_2 divide or split up the prolonged or united signals in the following manner. When the tongue or trailer of the receiving relay N S makes contact with the vibrating plate, say, on the left, and actuates the P.O. relay B_1 as shown, the circuit of the battery B_1 is closed through the coil s_1 of the cable transmitter, and the coil of the sounder T_1, thus applying one pole of the line battery B_2 to the second cable, and the battery B_2 to the retardation circuit U, and the coil of T_2, the second sounder. After an interval depending on the retardation of U, the current in T_2 becomes able to attract the armature of T_2, thus breaking the circuit of the battery B_1, on which the armature of coil s_1 of the cable transmitter is released, and cable 2 is put to earth. At the same time, the armature of the first sounder T_1 is released, thereby disconnecting the battery B_2 from the retardation circuit U and the coil of T_2, the second sounder. If the tongue of the P.O. relay B_1 be still deflected, that is to say, if the current from cable 1 still flows through the receiving relay in the same direction, a second current is passed through the coil s_1 of the cable transmitter and the coil T_1 of the first sounder, thus applying the batteries B_2 and B_2 to the retardation circuit U and the cable 2, respectively, a second time. This operation is repeated as long as the tongue of the P.O. relay B_1 is deflected by the trailer of the receiving relay, and at a rate which can be regulated by adjustment of the retardation circuit U to suit the speed of signalling adopted at the sending station of the first cable.

In some cases the adjustment of the two sounders T_1, T_2, can be made without employing a retardation circuit U, by simply using the retardation of the coils of the two sounders and supplementing it by the adjustment of the screws which hold the armatures against their upper limiting stops to effect the splitting of the outgoing signals at the correct rate.

Fig. 13 also illustrates one method of Dr. Muirhead for applying his "overflow" device to produce the right shape of signals for working the relay. The retardation circuit, or "overflow" W, is inserted between the back stops of the P.O. relays B_1, B_2, and a separate circuit on the signal coil of the receiving relay N, S, provided for this purpose. On the deflection of the tongue of

either P.O. relay B_1, B_2, a current overflows from the retardation circuit w, through the signal coil of the required strength and direction to form the right shaped signals for retransmission.

An extra sounder, T_3, is placed in series with T_2 to break the circuit of the P.O. relays B_1, B_2 in synchronism with the splitting up sounders T_1, T_2, so that the proper number of currents may be sent through the extra or "overflow" circuit of the signal coil.

Another method of Dr. Muirhead (Patent 10,120, 1901) for dividing or splitting up the prolonged signals, especially useful in distributing messages from a cable over landlines worked by the siphon recorder, is an adaption of his "perforator" used in connection with his curb transmitter. The perforator, fig. 14, as many

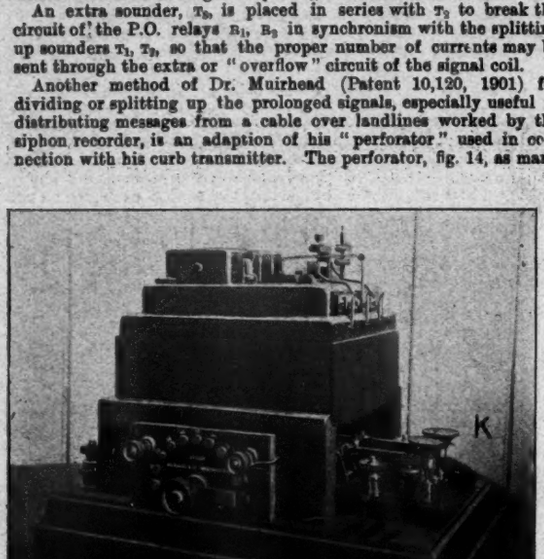


Fig. 14.

know, is a compact little apparatus for punching holes in the running tape or slip of paper which actuates the automatic sending key. There are three rows of holes in the tape, one central for the "spacing" of the message, and two at the sides, namely, one for the "dots" and another for the "dashes" of the signals. The tape thus perforated runs through the curb sender, works its levers and transmits the message into the line.

The perforator is usually manipulated by the operator pressing down one or other of three buttons or keys, K, seen in front, but when used as a divider or separator to split up the prolonged signals received from the first cable by the "plate" relay, and repeat them by the curb transmitter into the second cable or the land wire, as the case may be, the keys K are pulled down by means of three electro-magnets beneath them in the base of the instrument.

The arrangement will be understood from fig. 15, where N S is the plate relay in circuit with the first cable and earth, B_1, B_2, B_3, are Post Office relays working three electro-magnets M_1, M_2, M_3, actuating respec-

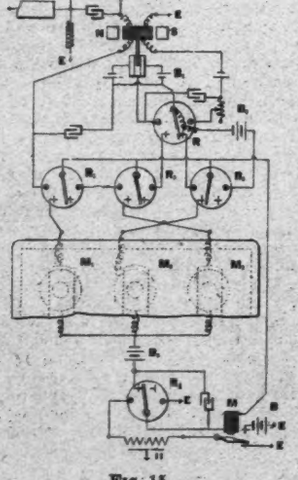


Fig. 15.

itvely the "dot," spacing, and "dash" punches of the perforator. The coils of these electro-magnets, together with another electro-magnet, M, and a battery, B, are inserted in the local circuits of the P.O. relays. The tongue of another Post Office relay, R, is connected to the middle of a split battery, B_1, of which the poles are joined to the vibrating plates of the receiving relay, and also to one pole of the separate battery, B_2, employed in conjunction with the P.O. relay, B_2, on the right hand. The coils of the two relays, B_1, B_2, are in series and connected one terminal to the tongue or trailer of the receiving relay, and the other to one of the fixed stops of the relay, R, of which the opposite fixed stop is joined to a terminal of the relay, B_2. The tongues of the relays, B_1, B_2, B_3, are connected to one terminal of the electro-magnet M, whose other terminal is joined to the tongue of the P.O. relay B_4 to complete the local circuit of the relays B_1, B_2, B_3, through the coils of the magnets M_1, M_2, M_3, which operate the punches of the perforator.

When there is no current from the cable, the trailer of the receiving relay rests on the middle or zero section of the plates, and keeps the circuit of the P.O. relay R closed, thus holding its tongue against the stop, which closes the circuit of the relay B_3, and sending a current from the battery B_3 through the coils of the perforating electro-magnet M_3, and the electro-magnet M, whose armature, when attracted, puts the battery B to a retarding circuit U, and after an interval, depending on the retardation of U, the tongue of the relay B_4 is deflected, and the circuits of the perforating magnet M_3, and of the electro-magnet M are interrupted. This train of operations is repeated as long as the trailer is on its middle position, and the result is a succession of spacing holes in the tape. When, however, a current from the cable deflects the trailer into contact with one or other vibrating plate, say, to the left, the circuit of the relay R is broken, and its tongue makes contact with the stop connected to one terminal of the two relays B_1 B_2, completing their circuit through the left half of the battery B_1, thus exciting the electro-magnet M and also the electro-magnet M_1, which perforates a "dot" hole. The relay B_2, however, is so polarised that it does not respond to this current. The circuit of the perforating electro-magnet M_1 is interrupted periodically by the electro-magnet M and the relay B_4, as long as the trailer continues on the left-hand vibrating plate, and the result is a series of "dot" holes in the tape corresponding to the elements of the received signal. By a similar train of operations a series of dashes is punched in the tape when the trailer comes into contact with the right-hand vibrating plate.

In conclusion, we may add that Dr. Muirhead is arranging to introduce the relay on the numerous coast or loop cables of the Central and South American Telegraph Company.

REFUSE DESTRUCTION.

Before the Exeter Congress of the Royal Institute of Public Health, held in August last, a paper was read by Mr. F. L. Watson, of the Horsfall Destructor Co., on "Recent Practice in Refuse Disposal and Utilisation Plants," and another by Mr. W. F. Goodrich, of Meldrum Bros., Ltd., entitled "A Few Facts Concerning Refuse Destructors." As might be supposed, the first-named deals principally with the most recent examples of the work carried out by the Horsfall Co., and gives some very well got-up plans of the destructor plants installed by that company. Three of these illustrate combined schemes of refuse destruction and electrical generating works, viz., those at Fulham, Accrington, and Beckenham.

The author also describes the various methods of clinker utilisation, such as brick and flag manufacture, mortar and concrete making, road bedding, &c., which, in some towns, more particularly in Bradford, form quite a lucrative business. As Mr. Watson points out, sewage pumping constitutes a better load for a destructor than does electric lighting, as the former is much more constant, and, from the economical point of view, it is better to run a destructor constantly than intermittently. It is insisted, and properly so, that evaporative tests of short duration have very little value, and only serve to discredit this system of refuse disposal, as the average results over a more lengthened period often fall very far short of such test results. The author, however, regards an evaporation of 1 lb. of water per pound of refuse as a very safe figure, and one that can very frequently be exceeded.

Mr. Goodrich's paper bristles with statistics, many of which are put in the form of diagrams after the manner usually adopted by J. Holt Schooling. One very interesting item is that at Sheerness, the erection of a destructor and the utilisation of its heat to generate power for pumping the town's water supply, will effect a saving in the coal account of £500 per annum, and the net result, after paying all expenses, will be the reduction of the rates by 1d. in the pound. Again, at Weymouth, a reduction of 1½d. in the rates is to result from utilising the destructor heat for sewage pumping and disposing of the clinker at 2s. 6d. a ton. These figures are the borough surveyor's estimate, which is given in detail. The results of several combined destructor and electricity works are given, these being the same as those dealt with in the series of articles on "Refuse Destruction," which recently appeared in this journal.

One of the most striking paragraphs in the paper is this:—"In one test with a four-grate unit Meldrum destructor working in connection with a Lancashire boiler 30 ft. long by 8 ft. in diameter, the average hourly evaporation from the boiler was actually 1,344 gallons, and the maximum for one hour during the test 1,646 gallons, a result never yet reached, even under forced conditions, with the finest Welsh coal, since Lancashire boilers were first made." These figures refer to the Nelson plant, and are the result of exhaustive tests by Mr. Priestley. The rated output of a Lancashire boiler of this size, fired by coal under ordinary conditions is 780 gallons; it is seen, therefore, that the evaporation given above is more than double this rate Now, if this result

is fairly claimed as a result of refuse firing, it means that with the latter the boiler plant might be considerably less than is necessary for coal firing. But is it so? Is the result not due to the higher temperature of the gases consequent upon forced draught, and to the increased volume of the gases due to the very large grate area—an area four times that of the ordinary internal fire grate? If coal, even a poor quality slack, were burnt on the destructor grates under the same conditions as the refuse is burnt, not only would a still higher evaporation be possible, but the temperature would be sufficient to melt the fire-brick lining of the furnaces.

This really opens up a very interesting question, and one we have several times referred to in previous numbers, viz., as to the advisability or economy of firing a Lancashire boiler externally, in a fire-brick chamber. It has been tried, with indifferent success, but it is an experiment we should like to see repeated under the best conditions. But apart from this, Mr. Goodrich's statement is open to question, for we have a copy of a series of tests on a 26 ft. × 7 ft. 6 in. boiler, fitted with a Meldrum sprinkler stoker, which gives results very nearly approaching the Nelson figures, and we understand that Messrs. Meldrum are prepared to equal the figures named, either with the sprinkler stoker, or with hand firing and their system of forced draught. The paper otherwise contains much useful data and information on refuse destructors generally.

THE MONARCH ENGINE STOP SYSTEM.

A simple and effective device, bearing the above title, for stopping steam engines and other motors from a distance, is being introduced into this country by Messrs. Drake & Gorham, Ltd. In case of accident of any kind which renders it necessary to shut down instantly, all that is required where this apparatus is adopted is to press a push-button, of which any number may be fixed in any part of the works concerned. In addition to this valuable feature, the system provides a safeguard against runaways, cuts off the connection with the condenser, and trips the circuit-breaker. Needless to say, all this is effected by electrical agency, as will be seen from the following illustrations.

Fig. 1 shows the Engine Stop open, while fig. 2 is a sectional view of the interior.

The mechanism is enclosed in a cylindrical iron case, or shell, in two parts, the upper half opening on hinges. Passing through this shell, and turning on ball bearings, is a steel shaft 1½ in. in diameter, on the outer end of which is attached a drum or pulley, to which is bolted a sprocket wheel H, as illustrated in fig. 2. Around this drum passes a wire cable G, to which is attached a weight which provides power to operate the device. Inside the case and fastened to the shaft is a ratchet-wheel F, engaged by a pawl B, which prevents the weight from turning the shaft in the direction that closes the valve. This pawl is held in engagement with the ratchet by a vertical lever D, which is held in position by the right, or trigger, end of the armature lever E. The magnets A are placed in circuit with an electric battery, and when the circuit is closed by pressing a button, the armature end of the lever E is pulled down, releasing the upper end of the vertical lever D, which also serves as a hammer, striking the lug of the pawl B, and throwing it out of engagement with the ratchet. This allows the shaft of the stop to revolve and close the valve by means of the sprocket chain attached to the sprocket wheel of the stop, engaging a similar sprocket wheel attached to the throttle valve stem, the weight, as before mentioned, furnishing the power. At the opposite end of the stop is a dash-pot, illustrated in fig. 2, which consists of a cylinder into which the piston P fits closely. On this end of the shaft is cut a square-threaded screw S, passing through a nut fastened in the centre of the piston P, so that as the shaft revolves, by means of this screw the piston is carried into the cylinder, and the air behind its inner face is compressed, thus forming a complete cushion. The speed at which the stop acts may be very accurately adjusted by turning the by-pass valve V, which governs the amount of air that is forced through the air passage H, in fig. 2, as the piston P moves in. Below this by-pass valve V, and in the piston P, is located a releasing valve O, which can be adjusted at will to open by contact against the bottom of the dash-pot, when the throttle valve is near its seat, allowing the compressed air to escape quickly, *after the piston has cushioned*, and thus allowing the valve to start again and take its seat softly, but with sufficient force to close it tightly.

Fig. 4 shows the Stop applied to the throttle valve of a horizontal engine.

The Speed Limit consists of a pair of governor springs arranged on a horizontal shaft, and provided with the usual central balls. When the speed increases to such a point above the normal as desired, the balls, separating by centrifugal force, move a sliding collar on the shaft to which they are connected, until this collar comes in contact with two electrical terminals, thus completing the

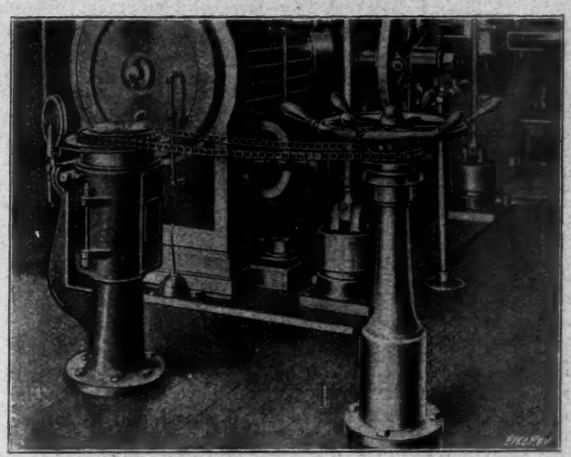


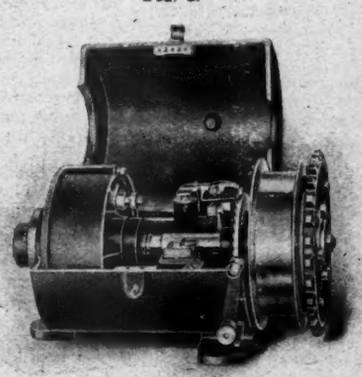
Fig. 4.—Application of Engine Stop.

circuit and putting the Stop in operation. The shaft of this machine is run on ball bearings, and is driven by a belt from the main or fly-wheel shaft of the engine.

The Vacuum Valve and Circuit Breaker Trip are shown in figs. 5 and 6; their mechanism is simple, while the importance of providing these safeguards, where the engines are fitted with the "Engine-Stop," needs no demonstration.

Each of these devices is set in operation by means of a pair of electro-magnets, which are electrically connected with the Engine Stop, so that the moment the latter comes into action and closes the throttle valve, the interior of the condenser is put in communication with the atmosphere. If the engine is driving a dynamo, the latter is at the same time isolated from the bus-bars.

Fig. 1. Fig. 5.



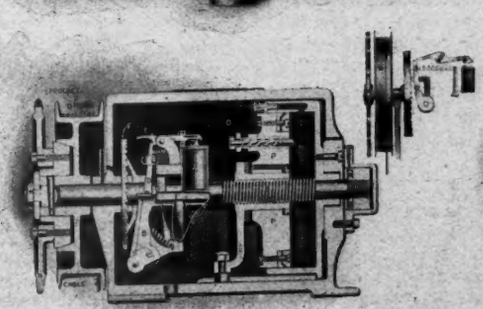


Fig. 2. Fig. 3. Fig. 6.

Messrs. Drake & Gorham are also dealing with the "Corliss electric engine stop" and vacuum breaker for the same purposes.

The Corliss Stop is intended to be applied to the governor, not to the throttle valve; it consists of a steam-actuated device controlled by an electro-magnet, which acts on the governor in such a way as to shut off the steam from the cylinder. The vacuum valve similarly breaks the vacuum.

THE OLD AND THE NEW ELECTRICAL THEORY.

By ALEX. P. TROTTER.

(*Concluded from page* 617.)

Transmission.

The idea that energy is transmitted along or through the wire is bound up with the notion of a steady continuous current. In the case of alternate currents, everyone readily admits that energy passes through the dielectric from the primary to the secondary of an induction coil or transformer, but the sceptic may answer that here there is no suggestion of a wire to act either as a path or as a guide. In reply, it may be suggested that it is more important to grant that electrical energy *can* be transmitted through space, than to understand *how* it is, under certain circumstances, guided by a conductor. It is more important, because when this is granted, progress can be made on the lines of the new theory, which, so far as it can be expressed in language which Faraday would have understood, fits nearly all the facts which have been observed, and so far as it is expressed in mathematical language, goes much further, and has enabled facts to be predicted and discovered.

"We are perpetually drawing inferences from our immediate and stored sense-impressions as to things which lie beyond immediate verification by sense; that is, we infer the existence of things which do not belong to the objective world, or which, at any rate, cannot be directly verified by immediate sense-impression as belonging to it at the present moment. Strange as it may seem, science is largely based on inferences of this kind; its hypotheses lie to a great extent beyond the region of the immediately sensible, and it deals chiefly with conceptions drawn from sense-impressions, and not with sense-impressions themselves."*

"People who think a little, but not much, sometimes ask me," said Prof. G. F. FitzGerald,† "'Why do you believe in the ether? What's the good of it?' I ask them, 'What becomes of light for the eight minutes after it has left the sun before it reaches the earth?' When they consider that they observe how necessary the ether is. If light took no time to come from the sun there would be need of the ether."

Heaviside‡ pointed out that if transmission of sound were very much faster than it is, the idea of speed would not present itself at all; we should perceive that the vibration of bodies would set distant bodies vibrating, and this might be described (not explained) as the induction of vibrations. The presence of air would not come into the theory. Nothing short of actual proof of the finite speed of sound would convince the prejudiced. It is now as much a fact that electro-magnetic waves are propagated outside conductors as that sound waves are propagated outside vibrating bodies. Attention would be paid entirely to the vibrating bodies just as attention has been paid to wires and magnets, and suppositional electric and magnetic fluids have been supposed to reside in them or on them, or to move about on or through them.

Vibrations.

Another point on which no information exists at present is the connection between ether and ordinary matter. That there is a connection, probably a mechanical connection, is clear from the fact that a luminous substance sets up vibratory motion in the ether; and conversely, ether waves falling on a body can set its parts or the whole body in motion. Oliver Lodge has tried to stir the ether mechanically and on a large scale, but without success, a most important experiment. The connection, where light and radiant heat are concerned, is chiefly with the molecules, but where electrical and magnetic forces are concerned, the whole mass of a body is pushed or pulled. The absence of an explanation of this connection does not give rise to any appreciable difficulties in the intelligent understanding of the sciences of optics and of radiant heat, and yet it seems to be one of the obstacles to the reception of the electrical theory. The mechanism by which a red hot poker sends out ether vibrations ranging from 200 to 600 million million per second, probably differs from that by which a dynamo sends out ether vibrations of 100 per second. The length of a wave of red light is about one 34-thousandth of an inch, the wave length of the dynamo vibration is about 2,000 miles. Little or nothing is known of ether, but it is as difficult to believe that the dynamo is sending out "electricity," as it is to believe that the poker is emitting "caloric" and light-corpuscles.

Oliver Heaviside treats the new theory from the point of view of electro-magnetic waves, and discusses in mathematical language their propagation, form and distortion. In speaking of the form of an ether wave, we must be careful not to create a wrong conception of what is intended. We shall be on safe ground if we can describe the conception in Faraday's language.

Let us consider, then, the waves of disturbances which are set up by a Hertz inductor or by the transmitter of a wireless telegraph apparatus as used by Marconi. The mode in which currents are caused to alternate about 100 million times a second need not be described here. Such an alternate current exists in the spark which passes between two knobs of the apparatus. If a steady continuous current were to pass in one direction (to use, for want of any other, the conventional terms of the old theory) there would be, in the language of Faraday, circular lines of force round the current as an axis. There would be a steady magnetic field, with no magnetic poles. This field would vary in strength, becoming weaker at a distance from the axis. If the strength of the field were represented on a diagram by the number of lines of force to the inch, they would lie as concentric circles close together near the axis, and spaced more widely at a distance from the axis. Now, suppose the strength of the current to be suddenly increased, maintaining it, however, in the same direction. The result, as shown on a diagram, would be to increase the number of lines of force, and their number per inch. But this change would not take place instantaneously, even if the strength of the current could change instantaneously. The change would begin at the axis, and would spread outwards at about 300,000,000 metres, or 187,000 miles per second. In one 300-millionth of a second the change would, therefore, have travelled 1 metre. Suppose now, that the current were to diminish suddenly to its original strength, the effect of the first change would go on spreading outward, like a circular ripple on a pond, the change being an increase of the number of lines of force per inch, and this would be followed by another change—a decrease of the number per inch. If this process were repeated at regular intervals of one three-thousandth of a second, we should have an alternating current and a series of changes of strength of magnetic field progressing outwards. The effect, as shown by a moving diagram, would resemble the ripples on a pond when the surface is gently disturbed at a point. Waves of sound spreading at about 1,100 ft. per second, might be represented by a similar diagram. The important point to be observed is, that the three cases, though represented by the same diagram, differ very widely. In the case of the pond, we have a flat surface disturbed or bent into solid waves. In the case of sound, we have spherical shells of air alternately compressed and rarified, spreading outwards, and having no resemblance to waves of water except by analogy. In the case of the electro-magnetic disturbances, the form might be spherical, but we may confine our attention to a moderately thin slice of the sphere. There is no surface disturbance like that of the pond, and since ether is almost incompressible, there is no appreciable condensation and rarifaction. But these waves consist also of electrostatic disturbances. These are everywhere at right angles to the electro-magnetic disturbances and introduce such complications that nobody has succeeded in grasping the real nature of the change in the ether. It is sufficient for the present to call it a displacement or a polarisation, and to define the motion of the waves as the transmission of a condition. In the case of sound waves the motion of the air is backwards and forwards in the direction in which the sound is travelling. In the case of light the motion is at right angles to the direction of the ray, and since there is every reason to

* Karl Pearson, "Grammar of Science," p. 63.
† British Association, 1888.
‡ Heaviside, *Electrician*, Vol. xxx., p. 239, par. 173.

suppose that light is nothing more or less than such an electro-magnetic disturbance, as that which we have been imagining, the motion of the ether, according to the elastic hypothesis, seems to be of the nature of a shear. A very simple shear of this kind would be set up in a jelly if a ball were embedded in it, and were given a twist and then allowed to fly back.* Spherical shear-waves would start out and travel through the jelly. But the ether motion is not so simple as this, and mathematicians who can put into the form of equations all the modes in which such vibrations could be set up in a jelly, and who also have before them Maxwell's equations which describe in mathematical language, the kind of vibrations which must take place in the ether in order to fit the observed facts of optics and electro-magnetism, tell us that the two sets of equations cannot be reconciled.

Electrons.†

A group of phenomena of which the Crookes radiations, cathode rays and Prof. J. J. Thomson's discharges in gases are examples, have led to the hypothesis of streams of electrically-charged corpuscles of far smaller dimensions than those which have been assigned to atoms. The cog wheels of Oliver Lodge are analogies, though he has described them so vividly that a reader of his "Modern Views" needs to remind himself that space is not really filled with such mechanism. But these charged corpuscles, appearing again in the theory of electrons, have discouraged many students who have been tempted to lay it aside until it is established, or perhaps abandoned; for a corpuscular theory of electricity, after the labours of Faraday, Maxwell and Hertz, appeared to be as retrogressive as a corpuscular theory of light. Electrons seemed to be related to the theory of ions, an orthodox conception of Faraday; orthodox, because it conflicted with no electrical or molecular theories, and merely gave the name of ions to hypothetical groups of molecules, grouped for the convenience of the chemist. But the latest electron is not a charged corpuscle, but the charge without the corpuscle. To the mathematical mind this presents no difficulty, but to the constructive mind it is like the grin without the Cheshire cat. The mathematician, as soon as he has expressed his conception in symbols makes no further demand on his imagination, but simply lets loose his algebra. He may condescend to interpret his results into words; sometimes he cannot, and he seldom considers it to be an omission. Fortunately, the jelly theory of ether provides a neat analogy. Mr. J. Swinburne imagines a slender tube to be thrust into a thin jelly, and a little of the jelly to be sucked out. The tube is withdrawn, and is thrust into another part, and the portion of jelly expelled. The tube is again withdrawn, and we have a negative and a positive strain set up in the jelly. No nucleus is necessary.

Conclusion.

Such is the state of the modern electrical theory so far as it is ready to be translated into ordinary language. It may be objected that these articles leave the matter in a very unsatisfactory condition, but it must be pleaded that every month brings fresh facts to light; some are unlooked-for discoveries, others, as a rule, of far greater value to science, are the result of patient experimental research along lines suggested by deliberate reasoning.

The six watertight compartments into which physical science has been divided are being broken down; the minor sub-divisions of voltaic and frictional electricity have already disappeared, and the misleading notions of quantity and intensity survive only on the labels on telegraph instruments. Electrical, magnetic, and optical science are blending imperceptibly into the great subject of radiant energy. Chemistry is linked to these on one side by electrolysis, and on another by Zeeman's discovery, and the theory of chemical affinity will soon fall in line. Molecular physics, elasticity, and gravitation are awaiting their turn; energy in a hundred convertible forms, and a single medium underlie the whole.

To frame a comprehensive theory in any one science is a far more difficult undertaking to-day than 20 years ago. It is far better that a theory, sound as far as it goes, should be incomplete, than that it should be encumbered by erroneous conception of misleading hypotheses. The student of physics of to-day is not disposed to agree altogether with Newton's dictum, "Nature is simple,"* but he values the precept which bids him deny himself the luxury of superfluous causes. "Neither more, nor more onerous causes," wrote Sir William Hamilton, "are to be assumed than are necessary to account for the phenomena." "The grand, and, indeed, only character of truth," said Sir John Herschel, "is its capability of enduring the tests of universal experience, and coming unchanged out of every possible form of fair discussion."

* "Popular Lectures and Addresses," Sir W. Thomson, Vol. 1, p. 350.

† This paragraph added in January, 1901.

* Karl Pearson, "The Grammar of Science," pp. 110, 492.

FEED WATERS AND THEIR ACTION ON BOILERS.

By CLIFFORD A. BOWEN.

(*Concluded from page 579.*)

The method of purification of feed water, by means of settling tanks, has far more to recommend it than the automatic devices that are on the market; they certainly advertise that they require very little looking after, but the worst of automatic feed purifiers is, that they don't do their work when your back is turned, and as for time, what is simpler, when once you know the quantity of water in the tanks, than to add the required amount of lime and soda, stir up all the sediment at the bottom; in a few minutes one can take a test and see exactly how hard or soft the water is. The reason one stirs up the sediment is, that being rather caked, it falls faster than the fine precipitate, due to the soda and lime bringing them down faster, so that in an hour one can commence to feed from the top of the freshly treated water, leaving the other tank to be filled afresh. The drawback to settling tanks is, that they occupy a lot of room; their first cost also goes against them, but the success which attends them fully repays this; the success is due to the accurate softening of the water.

The usual method of determining the hardness of water is by the soap test, first brought into use by Clarke, of Aberdeen. I believe the hardness of a water depends principally on the salts of lime and magnesia contained in it, and a determination of the degree of hardness affords some indication as to their quantity. This method depends upon the property possessed by the salts referred to of forming insoluble oleates or stearates with soap. When, therefore, a solution of soap and weak alcohol is added to the water and shaken, a permanent lathering will not take place till the whole of the lime and magnesia salts have been precipitated; but immediately the precipitation is complete, the slightest excess of soap forms, upon shaking, a fairly permanent frothy head. The hardness of water is of two kinds, permanent and temporary; temporary hardness is caused by carbonate of lime, so that if the water be boiled the carbonic acid gas is driven off and the carbonate of lime precipitates. The hardness that now remains is caused by sulphates, chlorides and nitrates of lime and magnesia.

The following is the method of testing:—Measure 50 cc. of water into a stoppered bottle of 200—250 cc. capacity; shake briskly to remove from the bottle any carbonic acid that may have been liberated; now add standard soap solution from a burette 2 cc. at a time; when the final point is nearly reached add the soap in smaller quantities, shaking well after each addition, and placing the bottle on its side. The test is complete when a soft creamy lather remains unbroken over the whole surface for five minutes; it is most important that the soap solution should be added in small quantities and be well shaken. Not more than 16 cc. of soap solution must be added; if this is not sufficient to cause a lather, smaller quantities of water must be used, say, 25 cc. or 10; then fill up with distilled water to 50 cc.; then, of course, multiply the result by two or five, as the case may be.

The following table shows the corresponding grains per gallon of $CaCO_3$ for each cc. of soap solution :—

Volume of soap solution.	Grains per gallon of $Ca\ CO_3$.	Volume of soap solution.	Grains per gallon of $Ca\ CO_3$.
1	·33	9·6	8·89
2	1·36	10	9·31
2·4	1·73	10·5	9·84
3	2·27	11	10·40
3·6	2·82	11·5	10·94
4	3·20	12	11·50
4·8	4	12·5	12·05
5	4·20	13	12·61
5·6	4·8	13·5	13·16
6	5·20	14	13·72
6·4	5·60	14·5	14·28
7	6·20	15	14·83
7·8	7	15·5	15·41
8	7·21	16	16
8·6	7·84	—	—
9	8·26	—	—

Standard soap solution is made as follows :—Take 10 grammes of best Castille soap containing 60 per cent. of olive oil, and dissolve in a litre of weak alcohol ; care must be taken to dissolve the whole of the soap. This yields a solution containing exactly sufficient soap in 1 cc. to precipitate 1 milligramme of carbonate of lime. The strength of the soap solution is verified by means of a solution containing a known quantity of carbonate of lime or calcium chloride (equivalent to a known quantity of carbonate of lime).

1·11 grammes of pure fused calcium chloride is dissolved in a litre of water ; this solution contains calcium chloride in the proportion of 1 milligramme of carbonate of lime in 1 cubic centimetre. 12 cc. of this solution is now taken and made up to 70 cc. with distilled water, so that in 70 cc. there are 12 milligrammes of carbonate of lime. 70 cc. of pure distilled water consumes 1 cc. of standard soap solution (= 1 milligramme of carbonate of lime) before it gives a good lather.

Therefore if the standard soap solution is of correct strength, it should take 13 cc. to give a good creamy lather to 70 cc. of the solution containing 12 milligrammes of carbonate of lime.

The reason why 70 cc. is used is because 1 gallon of water contains 70,000 grains, and 70 cc. contains 70,000 milligrammes, so that 70 cc. is a sort of miniature gallon, wherein each milligramme corresponds to 1 grain in the gallon. If we know the number of milligrammes of solid matter in 70 cc., we know the number of grains per gallon. Say, for example, you wanted to know the total solids in a gallon of water ; take, say, 250 cc. and evaporate in a porcelain dish (250 cc. is taken because the amount of solid matter in water is so small that it is difficult to weigh), dry thoroughly, and weigh. For example :—

Weight of dish and residue from 250 cc. of water	36·56 grammes.
Weight of empty dish	36·41 „
	·150 grammes.

Then ·150 × ·4 = ·06 grammes in 100 cc.
·06 × ·7 = ·042 grammes in 70 cc. } = 42 milligrammes in 73 cc. of water, or 42 grains in 1 gallon of water.

Another great curse to the engineer is the presence of free oxygen to be found in water. It enters the boiler, especially when fed with cold feed in the form of an hydrate (HO). The exact action taken by the hydrate is difficult to state ; some say that the galvanic action in the boiler exercises a chemical change with the iron, for being the more electro-positive metal, it combines with the hydrate, forming ferric hydrate (FEH_3O_3). The action of heat then converts the ferric hydrate into the oxide (rust), which breaks away from the iron during the working of the boiler, leaving the plates clean and open to the attack of fresh oxygen ; so the cycle of changes continues till the boiler becomes too thin to be safely worked. If the mud from the blowdown be examined, and is found to contain small particles of scale of a black-red colour, you may be sure that it is magnetic oxide of iron formed by the above process. Profs. Lewes and Brown, I believe, hold that the carbonic acid combines with the iron, forming ferrous carbonate ; the hydrogen being set free, the ferrous carbonate then takes up the free oxygen in the water forming ferric oxide (rust), and the carbonic acid becomes free, only to return to the attack as soon as the oxide is removed, and so the chemical action goes on in a cycle.

Pitting in a boiler is caused by the above action, in the presence of small particles of brass and copper. Copper and brass enter the boiler in this manner : condensed water flowing through copper condensers takes up any copper dust, and particles of copper from the condenser tubes ; also brass from the air pumps, which are made of gun-metal (liner, rod and bucket), finds its way into the boiler. These particles rest on the plates and tubes, causing galvanic action ; the result has already been referred to. There are two methods in use to prevent pitting and corrosion ; one is to wash the boiler with a very thin coating of cement, thereby insulating the plates from any substance that might enter the boiler and so cause galvanic action. This method was first tried at Liverpool many years ago on boats fitted with new boilers before going to sea, and was found to answer very well. The other method, which is universal, especially in marine practice, is the presence of slabs of zinc in boilers. These slabs of zinc are fixed on stays, or are fixed on a bolt from 3 to 8 in. long and screwed to the boiler plates, making good electrical contact. The action is obvious. The zinc, being the more electro-positive metal than the iron or brass and copper, gets eaten away just in the same way as the iron was eaten before a more electro-positive metal was put in. The zinc slabs should be of rolled zinc, which is more suitable than cast slabs. Corrosion may occur in boilers, and very severely, too, by the use of animal and vegetable oils, used in cylinder and piston rod lubrication, finding their way into the condensers and from there into the boiler. Tallow, which forms a great part of the above oils, is composed of fatty acids, chiefly stearic acid and glycerine, which when boiled with soda is decomposed into stearic acid, while the glycerine and soda form soap. Even without the aid of soda, tallow becomes decomposed when boiled at high temperature. Though stearic acid may be weak when compared with sulphuric and other mineral acids, yet it slowly and surely eats away the plates. Irregular corrosion and pitting may also occur from the irregular formation of the iron ; the corrosion has been attributed to the presence of slag and the irregular structure of the iron, the softer parts being the more readily attacked. The lesson to be learnt from the above, is the use of only the best hydro-carbon oils for parts of machinery from which there is the slightest chance of the oil finding its way into the boiler.

I will now pass on to some simple water tests showing the presence of iron, lime, magnesia, sulphuric acid, ammonia, nitric acid, and organic matter. Use a porcelain dish and not a glass one, because glass is attacked by boiling water, more so than porcelain.

1. Boil 2,000 grammes of carefully collected water in the porcelain dish down to one half. This generally produces a precipitate containing those constituents of the water which were only kept in solution through the agency of free carbonic acid as carbonate of lime, carbonate of magnesia, sesquioxide of iron ; pass the fluid through a filter perfectly clean and free from any trace of iron or lime, wash the precipitate well after removing the filtrate,* then examine both as follows :—

Dissolve the precipitate on the filter in the least quantity of dilute hydrochloric (effervescence shows carbonic acid) ; treat separate portions as follows :—

(*a*) Add sulphocyanide or ferrocyanide of potassium to test for iron ; if iron is present a blue precipitate is formed.

(*b*) Take another portion, boil with ammonia, filter if there is any cloudiness or precipitate, mix the filtrate with oxalate of ammonia in excess, and stand for some time in a warm place ; a white precipitate indicates lime as carbonate. Or if H_2SO_4 is present in the water as sulphate also, filter the precipitate and mix the filtrate again with ammonia, and add some phosphate of soda, stir well, and allow to stand for half a day ; white crystalline precipitate, which may often be visible only on the side of the glass when the fluid is poured out, indicates magnesia.

(*c*) Add some chloride of barium, and allow to stand for

some time, say, 10—17 hours; a white precipate means sulphuric acid is present.

Examine the filtrate marked *—

(*a*) Mix a portion with a little hydrochloric acid and chloride of barium; a white precipitate indicates sulphuric acid.

(*b*) Mix a portion with nitric acid and add nitrate of silver; a white precipitate or turbidity indicates chlorine.

(*c*) Evaporate a fairly large quantity of the filtrate to concentration point, add a little brucia dissolved in concentrated sulphuric acid, then the solution immediately acquires a magnificent red colour, indicating nitric acid. This is a very delicate test.

(*d*) Acidify a large portion of the water after filtering (to remove suspended matter) with hydrochloric acid and evaporate nearly to dryness; add hydrate of lime thoroughly mixed in a mortar; then if ammonia is present it betrays its presence by its characteristic odour, and if a glass rod dipped in hydrochloric acid is brought in contact with the solution, white fumes appear.

(*e*) Organic matter is detected by the blackening which occurs when a portion of the water is evaporated to dryness and gently ignited. The precipitate which is formed is at first white, then darkens, and, when the organic matter is driven off, returns to a light colour again.

The following are also some rapid tests for pure water. Water should show no change on the addition of sulphide of ammonia; if it does, it shows the presence of copper, iron, or lead :—

If carbonic acid is present baryta water turns it turbid; add oxylate of ammonia, and if lime is present the water becomes cloudy. If chloride of barium and hydrochloric acid be added to the water, the water becomes turbid if sulphuric acid is present. Nitrate of silver and nitric acid show chlorides if water changes colour; and chloride of mercury and carbonate of soda indicate ammonia.

ARE FREE LAMP RENEWALS DESIRABLE?*

By J. English.

Fifteen years ago we adopted the plan of free renewals, and have found it beneficial and wise. We could devise no way to induce the user to renew his lamps with even reasonable frequency as long as he had to pay anything for the lamp, but he would let the lamps burn until they broke, and complain to us that our service was poor. The necessities of a lamp renewal system seem to be that :—

1. Lamps should be renewed often enough to ensure the lamps in service maintaining a given candle-power during that service, or a limitation in fall of candle-power.

2. The renewals should be made in such a manner as to cause no annoyance to the user.

3. Renewals should be made often enough to obviate, practically, the necessity for customers ever calling for new lamps to replace those burned out.

4. The system adopted should be one that would effect the desired end in the most economical manner to the company.

We determined that a variation of two candles during the use of the lamp was as large as would furnish satisfactory service. Testing soon demonstrated the fact that with 3½-watt lamps we could not get an average burning of over 400 hours and keep the lamp within the above limits.

We therefore adopted a principle that all lamps on our circuits should be changed once in 400 hours. It was quite clear that with a widely varying character of service, if we changed uniformly all lamps at a given date we should remove many that had burned but a few hours and were good for many hours longer. It was equally plain that we could not assort these lamps in the places of installation, but we could bring all of them in to the station and then sort them by a photometer, discarding all lamps that were not 16 c.p., and putting in stock, to go out again, all that were 16 c.p. This method we have followed in our different stations for over seven years. We change every lamp on our mains four times per year, usually in February, May, August and November. We find that this results in very few lamps having been used over 400 hours. 40 per cent. of the lamps brought in are 16 c.p., and all right to go out again.

The results of this method have been fine, and the experience of 10 years has demonstrated :—

1. That all our lamps, while in service, are at least 14 c.p., or not at any time during their service more than 2 candles below the initial candle-power.

2. That this method delights the users, who feel they are really getting something for nothing. We no longer have occasion to send out lamps between periods of changes, and rarely hear of a broken lamp.

3. That the cost of this method is no greater than that of the ordinary method of making free renewals.

4. That the general effect on our business has been remarkably satisfactory; our lighting is good, better than any I have ever had occasion to examine.

5. That we have now passed beyond the point of complaints of service; we rarely see or hear from a user, unless it be on the question of rates.

Generally, therefore, I have not the slightest hesitation in saying that, in my opinion, no electric lighting company can afford to do business in the old ways, and that the sooner lighting companies recognise the inherent weakness of the incandescent lamp itself, and devote their energies to attempting to obviate the ill effects of this fault on the business, the more successful they will be.

By F. Ellwood Smith.

I used to believe that a lighting company should own nothing whatever inside a customer's building except the meter. The company's responsibility ceased when it had delivered the goods of proper quality and quantity at the meter. Theoretically, this may be true, but practically it is not the best method.

For a number of years I required my customers to buy all their lamps; either from our company at cost, or elsewhere, if they saw fit. They usually saw fit to buy elsewhere, getting an inferior lamp for less money, or not buying at all, and thus not using the electricity. To the average customer all incandescent lamps are alike; the customers know and care nothing about voltage and efficiency. I have found lamps used on our circuits consuming 5 watts per candle-power, and the customer thought he was getting a bargain when he bought this lamp for 15 cents instead of paying us 20 cents for one of our lamps, which would consume only 3·1 watts per candle-power. Many a time I have found 110-volt lamps on our 104-volt circuit, and customers finding fault with us because they did not get a good light. When customers have to pay for new lamps they will use the old lamps just as long as they will burn, and if one lamp does not give light enough, two must be used. The light is dim, and the bill is large; under such conditions the frequent result is a notice to the company to discontinue the service.

Several years ago I retained a number of customers that were dissatisfied, by simply giving them a few new lamps, and proving to them that the trouble was in the lamp, and not with the current. The results were so satisfactory, that I was obliged to become converted to the free-renewal belief, and to give my customers a new lamp for every old lamp returned.

The cost of the lamps is a necessary expense, just as much so as is fuel. A customer using a dim lamp of, say, 12 c.p., is paying for, say, 37 watts. You give him a new lamp giving 16 c.p., and consuming, say, 50 watts, he will be satisfied with the light, and willing to pay for the additional current. You will very soon get back the cost of the lamp, and get an increased revenue and a satisfied customer. I urge our customers to change their lamps often, and if a lamp is dim, to remove it. This request is printed on every monthly bill. We do not give new lamps in exchange for broken lamps, and exchange free only 8 c.p., 16 c.p., and 24 c.p. lamps. We sell new lamps of these candle-powers to our customers at 10 cents each.

I have not adopted the method of sending men to the customer's house and replacing his lamps, but I try to keep the dim lamps weeded out by circulars and notices on the monthly bills. This plan works fairly well, and I do not often have complaint of dim lights. I confess, however, to believing that a periodical systematic renewal of all lamps on the circuits is a very good thing.

All lamps returned are photometered, and if of sufficient candle-power, are put into stock to be used again. We retain those giving 14 c.p., and use them near the centre of distribution, where the voltage is a little greater.

I do not believe in furnishing free the first installation of lamps, especially in residences, because in a great many instances the return per lamp will be very small, and the cost of the first lamps will not keep away any desirable customers. I believe that every company furnishing electric current for incandescent lighting ought, for its own good, to furnish free incandescent lamp renewals.

By F. W. Little.

During the last three years we have entirely remodelled our generating plant and distributing system, entailing a large expense, and requiring a change of voltage of our secondaries from 52 to 104 volts, thus necessitating a change in consumers' lamps. This was done by an exchange on the basis of a charge of 20 cents for each new 104-volt lamp, and an allowance of 10 cents for each 52-volt lamp replaced. This resulted in bringing up the incandescent lamps on our system to a very good standard at a low cost to the consumer.

The above conditions have delayed our making any reduction in the selling price of lamps. We are now, however, considering selling lamps at cost, and renewals at a nominal price where consumers turn in burned-out lamps of the brand we handle. We believe this will ensure the use of first-class lamps on our circuits, and the freer use of current, due to the low cost of the lamps, without entirely cutting off the revenue from lamp sales. The renewal of lamps at a low cost, or free of cost, to the consumer, must be considered largely as an advertisement, but where established rates for current are such that concessions must be carefully counted before being allowed, we think it good policy to make each concession count for as much as possible.

* Abstract of joint communication read before the National Electric Light Association at Cincinnati, May, 1902.

By W. J. Greene.

From 1888 to 1893, free lamp renewals were furnished by us. In 1892 it became evident that the net earnings were not keeping proper pace with the growth of the plant and the increased investment. In 1893 this condition became critical, and a change of some kind became imperative. Two reforms were adopted: one, the adoption of a minimum charge proportional to the maximum-burning lamps; the other, the discontinuance of free lamp renewals. The desired results followed. These changes were soon followed by the adoption of a two-rate system in connection with the minimum charge, so that consumers upon whom fell the heavier cost of lamp renewals were many times compensated for such expense by the lower cost of service.

The reasons originally advanced in favour of charging for lamp renewals were:—

1. Reduction in operating expenses.

2. Consumers had been accustomed to maintaining equipments in all other methods of lighting, except arc lamps, and this company considered lamp renewals a legitimate expense to be borne by consumers. Nearly all of our customers concurred in this view.

The reasons for continuing present arrangements until such time as local conditions may make desirable the furnishing of free lamp renewals, are:—

1. The rapid increase of business, in the face of hard competition with gas, being difficult to provide for with increased capacity, owing to manufacturing delays and engineering difficulties, makes any check to growth, as may result from charging for lamp renewals, desirable.

2. Lack of facilities, under present office arrangements, to carry a supply of lamps and conveniently serve consumers with lamps from the office. Lamps, supplies and construction work are furnished by local supply houses, who are, on the whole, furnishing consumers with a good lamp at figures slightly in advance of cost.

3. Advantages accruing to supply houses from handling lamps and the better service they can render us in return.

4. Avoidance of the extra time required on the part of the management, and extra cost of rental for storage room, labour and lamps.

By Francis W. Willcox.

The custom of making the consumer supply his own lamps is a direct inheritance from the practice followed in gas lighting, of having the burners supplied by the consumer.

With the old simple tip burners it made little difference whether the consumer supplied them or not; the quality of the gas, and not the burner, determined the character of lighting service.

With incandescent lamps the case is quite different, the lamp being a complicated device, requiring technical knowledge to select the best type and proper efficiency. It also deteriorates in service, requiring replacement at fixed periods to maintain lighting results. In other words, we have here a case in which the burner is a feature having a large influence on results.

With the introduction of Welsbach lamps in gas lighting we have a burner quite similar in character and in results to the incandescent lamp. It would be natural to expect, therefore, that the same necessities that have caused so many electric lighting companies to provide for the supply of the lamps to their consumers, would cause gas companies to take up the supply and maintenance of Welsbach mantles.

In point of fact we find this very practice becoming adopted by gas companies. The arguments and reasons given for this step are exactly similar to those advanced for free electric lamp renewals, proven and established by practical experience with the Welsbach lamp in service. This result is, I think, quite positive and conclusive testimony in favour of free lamp renewals for electric lighting companies. The Welsbach mantle is a delicate device, and may be readily broken, with no evidence to show whether it failed of its own accord, or was deliberately broken. It would, therefore, seem necessary to make some nominal charge for renewals, to prevent fraud on the part of the consumer. This necessity does not exist with incandescent lamps, which can be readily broken only by destruction of the bulb, thus giving evidence of forcible or deliberate breakage. Free electric lamp renewals are, therefore, wholly practical, as not liable to cause any loss from fraud.

In his address before the Society of Engineers in London on February 3rd, 1902, President Griffith strongly advocated the supervision of mantles and burners:—

"The time is past when responsibility can be said to cease on the delivery of reasonably pure gas at a statutory pressure at the consumer's meter, and no gas manager can hope to maintain or extend the success of his undertaking unless he is prepared to assist the consumers in making the best use of the gas after delivery."

In his presidential address before the British Southern District Association of Gas Managers on March 6th, 1902, Mr. W. E. Price said:—

"As the incandescent burner is at present constructed, it is evident that its maintenance by gas companies must be undertaken, otherwise many consumers will throw it aside as being troublesome. Quite a number of gas companies have already adopted some method of maintenance, though there does not appear to be a unanimity of opinion as to which is the best."

In his address before the Manchester District Institute of Gas Engineers in March, 1902, President Arthur Graham says:—"The supplying and fixing of ordinary flat-flame burners free of cost to the consumer, also the maintaining, cleaning and renewals of mantles in the case of incandescent burners, at a nominal charge, although in themselves unprofitable transactions, are calculated to do more in the way of satisfying the users of gas and popularising the supply than any amount of discount or similar inducements to prompt payments."

The *Gas World*, January 4th and 11th, 1902, gave particulars of the methods of carrying out the system adopted respectively by the South Metropolitan, Sheffield, York, Ipswich, Wakefield and Tunbridge Wells Gas Companies.

It would be interesting to hear how far this practice is being adopted in the United States.

With gas companies adopting such practice, how can the electric lighting company omit the control of lamp renewals or free supply of lamps, and hope to compete in lighting work?

NEW PATENTS, 1902.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, to whom all inquiries should be addressed.

21,185. "An improved method of and apparatus for automatically operating telephone exchanges." L. E. De Mole. September 29th.

21,201. "Process and apparatus for the manufacture of accumulator plates." M. A. Adam. (Ludwig Engelmann, Germany.) September 29th.

21,202. "Improvements in or connected with dynamo-electric machines." J. H. St. Hill Mawdsley. September 29th.

21,213. "Improved method of and means for lighting miners' and other lamps by electricity." W. Patterson and C. Darrah, Junr. September 30th.

21,217. "Improvements in the construction of regulating switches for use in connection with electrical installations." A. Normanton and F. J. McElroy. September 30th.

21,229. "Improvements relating to automatic electrical switches." C. H. Offord and T. H. Marsh. September 30th.

21,236. "Improvements in and relating to steering gear for motor road vehicles, electric or steam launches, and the like." T. Mathewson and A. J. Fielding. September 30th.

21,267. "Secret electrical interrupter." E. Zay. September 30th.

21,279. "Improvements in the manufacture of incandescing electric lamps." T. W. Lowden. September 30th.

21,301. "Improvement in or relating to telegraphic apparatus engines on ship board." J. C. Kay and J. G. Kay. September 30th.

21,346. "Improvements in or relating to electric arc lamps." The Jandus Arc Lamp and Electric Co., Ltd., and A. D. Jones. October 1st.

21,370. "Improvements in devices for suspending electric lamps and other lighting apparatus." W. H. Pick. (Trading as Collins & Co.) October 1st.

21,388. "Improvements in electricity meters." G. C. Fricker and W. M. Mordey. October 1st.

21,453. "Improvements in capstans operated by electricity." F. W. Hollick. October 2nd. (Complete.)

21,471. "Electrically actuated and controlled clock." J. A. Carruthers. October 2nd. (Complete.)

21,473. "Improvements in machinery or apparatus for perforating telegraphic tape suitable for use in the automatic transmission of telegraphic messages." F. G. Creed. October 2nd.

21,488. "An improvement applicable to trolley heads for electric tramcars to guide the line wire into the groove of pulley when changing the direction of the car." W. H. Cook, T. Cook and W. E. Partington. October 3rd.

21,490. "Improvements in wireless telegraphy." F. Biddle and J. Crowley. October 3rd.

21,521. "Electric fire alarm." A. Pizzala and A. G. Griffin. October 3rd.

21,604. "An electric cordgrip lampholder and shade carrier." A. M. C. Joannidi and C. Hesford. October 4th.

21,616. "An improvement in the construction of commutators for series-wound brush dynamos." W. Hodgson. October 4th.

21,628. "An electro-magnet friction clutch." K. St. George Kirke and F. Churchill. October 4th.

21,629. "Improvements in armatures." E. A. M. Bindloss. October 4th.

21,648. "Improvements in the control of the electromotors on electric railway cars." Siemens Bros. & Co., Ltd., F. Lydall, and A. M. Duke. October 4th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson and Co., 322, High Holborn, W.C., and at Liverpool, price, post free, 9d. (in stamps).

1900.

13,999. "Improvements in arc lamps." L. Benard. Dated August 3rd, 1900. A clutch lamp has a frame consisting of a top plate connected by uprights with a base plate, which carries a guide and side rods supporting a ring with rods, and a collar holding an arc-closing cylinder against asbestos packing. The lower end of the glass cylinder is closed by an asbestos washer, held in its neck by the flange of a lower carbon holder, which is held down by a screw ring. The conductor to the lower holder is passed through a porcelain tube. The upper carbon passes through a loose gas check into a slotted tube, which slides in a guide, and carries a tubular core in a series solenoid. 5 claims.

14,054. "Improvements in indicators for electric bells and the like." Sax and Co., and J. and J. Aird. Dated August 4th, 1900. Relates to indicators for electric bells, &c. 2 claims.

14,086. "Improvements in the starting devices of explosive vapour motors." F. W. Hayward and R. C. Fox. Dated August 7th, 1900. Starting. The charge in the cylinder is ignited at starting by an electric current which passes through the stud and the arm on the disc which is held against it by a spring. As soon as the engine is started, the disc is turned by friction, until the arm is arrested by the stop so that the igniting circuit is broken and untimely ignition is prevented. 2 claims.

14,088. "Improvements in wireless or Hertzian telegraphy." A. C. Brown. Dated August 7th, 1900. Relates to arrangements in connection with the aerial condition in wireless telegraphy. The post is formed of metal or of wood, &c., with a surface partially or wholly of metal, and is made sufficiently rigid to be supported by insulators without employing guy ropes or stays above the level of the structure to which it is attached. The post, preferably tubular, and either of metal or metal supported on an internal wooden or other rod, is a modified form of the broad strip described in Specification No. 29,955, A.D. 1896. The spark gap and coherer are arranged either between parts of the conducting post or between the post and earth or a capacity. Spark knobs and coherer connections are shown; this circuit includes a long-range switch. The attachments of the local circuit connections are made as far apart as possible. The provisional specification describes a post in three portions, the gaps containing the spark gap and coherer, and a sleeve being provided for protecting the part not in use. 8 claims.